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THE ECONOMIC OUTLOOK—PRESENT AND PROSPECTIVE.

By Hon. DAVID A. WELLS.

ECONOMIC DISTURBANCE SERIES No. VIII.

PART III.

ATTENTION is next asked to the *second* (assumed) cause for the prevailing discontent of labor, namely:

Changes in the character or nature of employments consequent upon the introduction of new methods—machinery or processes—which it is claimed have tended to lower the grade of labor, impair the independence, and restrict the mental development of the laborer.

That such changes have been in the nature of evil, can not be questioned; but they are not new in character, nor as extensive in number and effect as is popularly supposed. Subordination to routine and method is an essential element in all systematized occupations; and in not a few employments and professions—as in all military and naval life, and in navigation and railroad work—an almost complete surrender of the independence of the individual, and an unreasoning mechanical compliance with rules or orders, are the indispensable conditions for the attainment of any degree of successful effort. In very many cases also the individual finds compensation for subordination and the surrender of independence in the recognition that such conditions may be but temporary, and are the necessary antecedents for promotion; and routine and monotony are doubtless in a greater or less degree alleviated when the operative can discern the plan of his work as an entirety, and note its result in the form of finished products. But in manufacturing operations, where the division of labor has been carried to an extreme;

where the product of the worker is never more than a fraction of any finished "whole," and where no greater demand is made upon the brain than that it shall see that the muscles of the arm, the hand, or the finger execute movements at specific times and continuously in connection with machinery, there are few such compensations or alleviations; and the general result to the individual working under such conditions can not, to say the least, be in the line of either healthy mental or physical development. Happily, however, the number of industries, in which division of labor and its subordination to machinery has been productive of such extreme results, is not very large; the manufacture of boots and shoes by modern machine methods, in which every finished shoe is said to represent sixty-two distinct mechanical employments or products, being perhaps the most notable. And yet even here there is not a little in way of compensating benefit to be credited to such a system. Thus, for example, it is stated that "the use of machinery has compelled employés to apply themselves more closely to their work; and, being paid by the piece, has enabled them to make better wages." When shoemaking was a handicraft, "the hours of labor were very irregular; the workmen, who decided their own hours of labor, working some days only a few hours, and then working far into the night for a few days to make up for lost time. It was once customary for shoemakers (in New England) to work on an average fifteen hours a day;" now the hours of labor in the shoe-factories are not in excess of ten hours. It is also claimed that the introduction of the sewing-machine into the manufacture of boots and shoes has greatly increased the opportunities for the employment of women, at better rates of wages. In the manufacture of clothing, which, in routine and monotony, is analogous to the manufacture of boots and shoes, it is generally conceded that the influence of the sewing-machine has been to increase wages, and that "notwithstanding the constantly growing use of these machines, the number of employés is greater than formerly, owing to the enlargement of the business." * Furthermore, the "collective work which admits of being carried on by the factory principle of great subdivision of labor and by the bringing together of large numbers of people under one roof and one control" does not at present, in the United States, give occupation to more than one in ten of all who follow gainful occupations in the whole country; while for the other nine the essential elements of industrial success continue, as of old, to be found in individual independence and personal mental capacity; and this experience of the United States will probably find a parallel in all other manufacturing countries.

* "Report on the Statistics of Wages," J. D. Weeks, U. S. Census, vol. xx.

The supersedure of men by women and young persons in textile manufactories, which (as previously noticed) has occurred to such an extent in New England that certain factory towns have come to be popularly designated as "she-towns," at first thought seems deplorable. But, on the other hand, it is certain that such supersedure has been mainly the result of such a diminution of the severity of toil through the improvements in machinery, or such a greater division of labor consequent upon new methods of production, as have opened up new opportunities for employment to women, by making it possible for them to do easily work which, under old systems, required the greater strength and endurance of men; children, for example, being able to spin yarn on a "ring-frame," which men alone were able to do on a "spinning-mule." And, however such changes may be regarded from the standpoint of the male operatives, the greater opportunity afforded for continuous work at higher wages than could be readily obtained in other occupations, is probably not regarded by the women in the light of a misfortune. Experience also shows that the larger the scale on which capitalistic production and distribution is carried on, "the less it can countenance the petty devices for swindling and pilfering," and the neglect and disregard of the health, safety, and comfort of operatives, which so frequently characterize industrial enterprises on a small scale; or, in other words, the maintenance of a high standard of industrial and commercial morality is coming to be recognized by the managers of all great enterprises as a means of saving time and avoiding trouble, and therefore as an undoubted and important element of profit. And it is to these facts—the natural and necessary growth of what has been termed the "capitalistic system"—that a recent English writer on the condition of the working-classes, largely attributes the suppression of the truck (store) system, the enactment of laws limiting the hours of labor, the acquiescence in the existence and power of trade-unions, and the increasing attention to sanitary regulations; reforms that have reformed away the worst features of the condition of labor as it existed thirty or forty years ago in Great Britain.* The larger the concern, the greater usually the steadiness of employment, and the more influential the public opinion of the employed.

Dr. Werner Siemens, the celebrated German scientist and inventor, in a recent address at Berlin on "Science and the Labor Question," claimed that the necessity for extensive factories and workshops—involving large capital and an almost "slavish" discipline for labor—to secure the maximum cheapness in pro-

* "The Condition of the Working Class in England in 1844," by Frederick Engles.

duction, "was due, to a great extent, to the yet imperfect development of the art of practical mechanics"; and that mechanical skill will ultimately effect "a return to the system (now almost extinct) of independent, self-sustaining domiciliary labor" by the introduction of cheap, compact, easily set up and operated labor-saving machinery into the smaller workshops and the homes of the workingmen. Should the difficulties now attendant upon the transmission of electricity from points where it can be cheaply generated, and its safe and effective subdivision and distribution as a motive force, be overcome (as it is not improbable they ultimately will be), thus doing away with the necessity of multiplying expensive and cumbersome machinery —steam-engines, boilers, dams, reservoirs, and water-wheels— for the local generation and application of mechanical power, there can be no doubt that most radical changes in the use of power for manufacturing purposes will speedily follow, and that the anticipations of Dr. Siemens, as to the change in the relations of machinery to its operatives, may at no distant day be realized.

The third cause which has especially operated in recent years to occasion discontent on the part of labor has been undoubtedly *the increase in intelligence or general information on the part of the masses in all civilized countries.*

The best definition, or rather statement, of the essential difference between a man and an animal that has ever been given is, that a man has progressive wants, and an animal has not. Under the guidance of what is termed instinct, the animal wants the same habitat and quantity and quality of food as its progenitors, and nothing more. And the more nearly man approaches in condition to the animal, the more limited is the sphere of his wants, and the greater his contentment. A greater supply of blubber and skins to the Esquimaux, more "pulque" to the native Mexican, to the West Indian negro a constant supply of yams and plantains without labor, and the ability to buy five salt herring for the same price that he has now to give for three, would, in each case, temporarily fill the cup of individual happiness nearly to repletion. And, among civilized men, the contentment and also sluggishness of those neighborhoods in which the population come little in contact with the outer world and have little of diversity of employment open to them, are proverbial. Now the wonderful material progress which has been made within the last quarter of a century has probably done more to overcome the inertia, and quicken the energy of the masses, than all that has been hitherto achieved in this direction in all preceding centuries. The railroad, the steamship, and the telegraph have broken down the barriers of space and time that

formerly constituted almost insuperable obstacles in the way of frequent intercourse between people of different races, countries, and communities, and have made the civilized world, as it were, one great neighborhood. Every increased facility that is afforded for the dissemination of intelligence, or for personal movement, finds a marvelously quick response in an extended use. The written correspondence—letters and cards—exchanged through the world's postal service, more than doubled between the years 1873 and 1885; while in the United States the number of people annually transported on railroads alone exceeds every year many times the total population of the country; the annual number for the New England States being more than sixteen times greater than their population. Under these powerful but natural educating influences, there has been a great advance in the intelligence of the masses. They have come to know more of what others are doing; know better what they themselves are capable of; and their wants have correspondingly increased, not merely in respect to quantities of the things to which they have always been accustomed, but very many articles and services which within a comparatively recent period were regarded as luxuries, are now almost universally considered and demanded as necessities. At the same time, the increased power of production and distribution, and the consequent reduction in the cost of most commodities and services, have also worked for the satisfaction of these wants in such a degree that a complete revolution has been effected during recent years in the every-day life of all classes of the people of the great industrial and commercial countries. Let any one compare the condition of even the abject poor of London, as described in recent publications, with the condition of English laborers as described by writers of acknowledged authority not more than forty years ago,* and he can not resist the conclusion that the very outcasts of England are now better provided for than were multitudes of her common laboring-men at the period mentioned.

But the widening of the sphere of one's surroundings, and a larger acquaintance with other men and their pursuits, have long been recognized as not productive of content.† Writing to his nephew a hundred years ago, Thomas Jefferson thus concisely

* The condition of agricultural laborers in general, and large classes of artisans, in the United Kingdom, forty or fifty years ago, as described by Carlyle in his "Past and Present" and "Sartor Resartus," and by another most reliable English authority, Mr. W. T. Thornton, in his "Overpopulation and its Remedy," was so deplorable that it is now difficult to realize that it ever existed.

† Increased facility for communication between Great Britain and the United States has without doubt been a large factor in occasioning the present profound discontent of Ireland; and political subjugation and their existing land system have been more intolerable to the Irish peasant and artisan, since they have been enabled to compare the in-

expressed the results of his own observation: "Traveling," he says, "makes men wiser, but less happy. When men of sober age travel they gather knowledge, but they are, after all, subject to recollections mixed with regret; their affections are weakened by being extended over more objects, and they learn new habits which can not be gratified when they return home." Again, as the former few and simple requirements of the masses have become more varied and costly, the individual effort necessary for the satisfaction of the latter is not relatively less, even under the new conditions of production, than before, and in many instances is possibly greater. Hence, notwithstanding the large advance in recent years in the average rates of wages, and their increased purchasing power, there is no less complaint than formerly of the cost of living; when (as M. Leroy-Beaulieu has pointed out in the case of France*) the foundation for the complaint is for the most part to be found in the circumstance that a totally different style of living has been adopted, and that society makes conformity with such different style a standard of family respectability.

There is, therefore, unquestionably in these facts an explanation of what to many has seemed one of the greatest puzzles of the times, namely, that with greater and increasing abundance and cheapness of most desirable things, popular discontent with the existing economic condition of affairs does not seem to diminish, but rather to greatly increase. And out of such discontent, which is not based on anything akin to actual and unavoidable poverty, has originated a feeling that the new conditions of abundance should be further equalized by some other methods than intelligent individual effort, self-denial, and a natural, progressive material and social development,† and that the state

stitutions under which they live with those which their expatriated fellow-countrymen enjoy elsewhere.

* "The Fall in the Price of Commodities: its Cause and Effect," by Leroy-Beaulieu. *Economiste français, April, 1887.*

† As it is important to make clear the full force and meaning of the term "self-denial" and "natural progressive material and social development," as above used, attention is asked to the following considerations: The investigations of Mr. Atkinson show that an increase of five cents' worth of material comfort per day, for every day in the year, to each inhabitant of the United States, would require the annual production and equitable distribution of more than $1,000,000,000 worth of commodities! In the last analysis, therefore, national prosperity and adversity are measurable by a difference which is not in excess of the price of a daily glass of beer; or, if five cents' worth of product for each inhabitant could be added to the capital of the country in excess of the average for each day in the year, such a year, by reason of its increased exchanges and sum of individual satisfactions, could not be other than most prosperous.

Again, the extraordinary and comparatively recent reductions in the cost of transportation of commodities by land and water (in the case of the New York Central and Hudson River Railroad, for example, from an average of 3·45 cents per ton per mile in 1865 to

could, if it would, make all men prosperous; and therefore should, in some way not yet clearly defined by anybody, arbitrarily intervene and effect it. And this feeling, so far as it assumes definiteness of idea and purpose, constitutes what is called "socialism." *

The following additional results—industrial and social—which have been attendant upon the world's recent material progress are also worthy of consideration by all desirous of fully comprehending the present economic situation, and the outlook for the future.

ADVANCE IN WAGES.—The average rate of wages, or the share which the laborer receives of product, has within a comparatively recent period, and in almost all countries—certainly in all civilized countries—greatly increased. The extent of this increase since 1850, and even since 1860, has undoubtedly exceeded that of any previous period of equal duration in the world's history.

Mr. Giffen claims as the result of his investigations for Great Britain, that "the average money-wages of the working-classes of the community, looking at them in the mass, and comparing the mass of *fifty* years ago with the mass at the present

0·68 of a cent in 1885), which have reduced the prices of the common articles of food to the masses to the extent of substantially one half, did not involve in their conception and carrying out any idea of benefiting humanity; but on the contrary those immediately concerned in effecting the improvements that have led to such results, never would have abated the rates to the public, but would have controlled and maintained them to their own profit, had they been able. But, by the force of agencies that have been above human control, they have not only not been able to do so, but have been constrained to promptly accept business at continually decreasing rates, as a condition of making any profit for themselves whatever. And what is true of the results of improvements in the transportation of products is equally true of all methods for economizing and facilitating their production. They are all factors in one great natural movement for continually increasing and equalizing abundance.

* On this point the Commissioner of the Bureau of Labor Statistics of the State of Connecticut, in his report for 1887, speaks as follows: "Necessary wants have multiplied, and society demands so much in the style of living that the laboring-man finds it almost impossible to live as respectably now on his wages as his father did thirty years since upon his. That is, wages have not kept pace with the increasing wants and style of living demanded by society. The laborer thinks he sees a wider difference between the style in which his employer lives and the way he is compelled to live, than existed between employer and employés thirty years ago. He thinks that this difference is growing greater with the years. Now, as a man's income is, in general, measured by his style of living, he can not resist the conclusion that a larger share of the profits of business goes to his employer than employers received in former years; that the incomes of employers have increased more rapidly than the wages of employés. The laboring people are fully alive to the fact that modern inventions and the like make larger incomes possible and right. They do not complain of these larger incomes, but they do believe most profoundly that they are not receiving their fair share of the benefits conferred upon society by these inventions and labor-saving machines. In this belief lies the principal source of their unrest."

time, have increased very nearly 100 per cent.* It is also conceded of this increase in Great Britain, that by far the largest proportion has occurred within the later years of this period, and has been concurrent with the larger introduction and use of machinery. Thus the investigations of Sir James Caird show that the advance in the average rate of wages for agricultural labor in England in the twenty-eight years between 1850 and 1878 was 45 per cent greater than the entire advance that took place in the eighty years next preceding 1850.

Mr. Giffen has also called attention to an exceedingly interesting and encouraging feature which has attended the recent improvement in money-wages in Great Britain—and which probably finds correspondence in other countries; and that is, that the tendency of the economic changes of the last fifty years has been not merely to augment the wages of the lowest class of labor, but also to reduce in a marked degree the proportion of this description of labor to the total mass—"its numbers having diminished on account of openings for labor in other directions. But this diminution has at the same time gone along with a steady improvement in the condition of the most unskilled laborers themselves." So that, if there had been no increase whatever in the average money-wages of Great Britain in recent years, the improvement in the general condition of the masses in that country "must have been enormous, for the simple reason that the population at the higher rate of wages has increased disproportionately to the others." But all this is only another way of proving that machinery always saves or minimizes the lowest and crudest kinds of labor. One of the most interesting and unquestionably one of the most accurate investigations respecting the change in wages since 1850, in the leading industries of Great Britain, was made in 1883 by Mr. George Lord, President of the Manchester (England) Chamber of Commerce. The results showed that the percentage increase in the average wages paid in eleven of the leading industries of that city between 1850 and 1883 was 40 per cent; the increase ranging from 10·30 per cent in mechanical engineering (fitters and turners) to 74·72 per cent in the case of other mechanics and in medium cotton spinning and weaving. In the United States, according to the data afforded by the census returns for 1850 and 1880, the average wages paid for the whole country increased

* This statement was first made by Mr. Giffen in 1883, in his inaugural address as President of the Royal Statistical Society of England, and was received with something of popular incredulity. But recurring to the same subject in another communication to the same society in 1886, Mr. Giffen asserts that further investigations show that there is no justification whatever for any doubts that may have been entertained as to the correctness of his assertions.

during the interval of these years by 39·9 per cent; or in a slightly smaller ratio of increase than was experienced during the same period in the industries of that district of England of which the city of Manchester is the center. The figures of the United States census of 1850 can not, however, be accepted with confidence.*

As respects agricultural labor in the United States, the assertion is probably warranted that, taking into account the hours of work, rates of wages, and the prices of commodities, the average farm-laborer is 100 per cent better off at the present time than he was thirty or forty years ago. In Massachusetts the average advance in the money-wages of this description of labor between 1850 and 1880 was 56 per cent, with board in addition. Between 1842 and 1846 the wages of agricultural labor in the United States sank to almost the lowest points of the century. According to the investigations of the Massachusetts Bureau of Labor Statistics, the average advance in general wages in that State from 1860 to 1883 was 28·36 per cent, while the conclusions of Mr. Atkinson are that the wages of mechanics in Massachusetts were 25 per cent more in 1885 than they were in 1860.

Taking the experience of the cities of St. Paul and Minneapolis as a basis, recent investigations also show a marked increase in the average wages of all descriptions of labor in the northwestern sections of the United States, comparing 1886 with 1875, of at least 10 per cent. In all railroad-work, the fact to which Mr. Giffen has called attention as a gratifying result of recent English experience also here reappears—namely, that the proportion of men earning the highest rates of wages is much greater than it was ten years ago, or more skilled workmen and fewer common workmen are relatively employed.

A series of official statistics, published in the "Annuaire statistique de la France," respecting the rates of wages paid in Paris and in the provinces of France in twenty-three leading industries during the years 1853 and 1883 respectively, show that, during the period referred to, the advance in average wages in Paris was 53 per cent and in the provinces 68 per cent, the figures being applicable to 1,497,000 workmen out of a total of 1,554,000 ascertained to be occupied in these industries by the French census of 1876.† M. Yves Guyot, the eminent French

* It is at the same time not a little significant that the Commissioner of the Massachusetts Bureau of Labor Statistics should have reported in 1884, as the result of his investigations, that while from 1872 to 1883 wages advanced on an average 9·74 per cent in Great Britain, they declined on the average in Massachusetts during the same period 5·41 per cent.

† "On the Comparative Efficiency and Earnings of Labor at Home and Abroad," by J. S. Jeans, "Journal of the Royal Statistical Society" (G. B.), December, 1884.

economist, is also the authority for the statement that the average daily wages of work-women in France engaged in the manufacture of clothing, lace, embroideries, laundry-work, and the like, increased 94 per cent between the years 1844 and 1872. In the cotton-mills at Mülhausen, Germany, the rates of increase in wages between 1835 and 1880 range between 60 and 256 per cent, the increase in the later years, as in other countries, having been particularly noticeable.

Accepting the wage statistics of France (and they are official), it would, therefore, appear that the rise of wages in that country during the years above reviewed was greater than was experienced in either England or the United States.

One factor which has undoubtedly contributed somewhat to the almost universal rise of wages during the last quarter of the century has been the immense progress that has been made in the abolition of human slavery—absolute, as well as in its modified forms of serfdom and peonage—which thirty years ago existed unimpaired over no inconsiderable areas of the earth's surface, and exerted a powerful influence for the degradation of labor and reduction of average wages to a minimum.

Relation of Wages to Living.—All conclusions as to the effect of changes in the rates of wages in any country are, however, incomplete, unless accompanied by data which permit of a conversion of wages into living, and these, in the case of the United States and for the period from 1860 to 1885, have been furnished by Mr. William M. Grosvenor, through a careful tabulation of the prices of two hundred commodities, embracing nearly all those in common use. From these comparisons it appears, that, if the purchasing power of one dollar in gold coin in May, 1860, be taken as the standard—or as one hundred cents' worth—the corresponding purchasing power of a like dollar in the year 1885 was 26·44 per cent greater. The artisan in Massachusetts in this latter year, therefore, could either "have largely raised the standard of his living, or, on the same standard, could have saved one third of his wages." Similar investigations instituted in Great Britain (and which had been before noticed) indicate corresponding results.

Another conclusion of Mr. Atkinson would also seem to be incapable of contravention, namely: That the greatly increased product of the fields, forests, factories, and mines of the United States which has occurred during the period from 1860 to 1885 "must have been mostly consumed by those who performed the actual work, because they constitute so large a proportion—substantially about ninety per cent—of the whole number of persons by whom such products are consumed," and that "no other evidence is needed to prove that the working man and woman of

the United States, in the strictest meaning of these words, are, decade by decade, securing to their own use and enjoyment an increasing share in a steadily increasing product." *

The report of the Bureau of Industrial Statistics of the State of Maine, for the year 1887, also presents some notable evidence of the continued increase in the purchasing power of wages; and show that, taking the experience of a typical American family in that State, deriving their living from manufacturing employments, as a basis, as much of food could be bought in 1887 for one dollar as would have cost $1.20 in 1882 and $1.30 in 1877; the difference being mainly due to reductions in the prices of flour, sugar, molasses, fresh meats, lard, oil, and soap.

In a paper presented to the British Association in 1886 by Mr. M. G. Mulhall, the increase in the purchasing power of money as respects commodities, and its decrease in purchasing power as respects labor in England during the period from 1880–'83 as compared with the period from 1821 to 1848, was thus illustrated by being reduced to figures and quantities: Thus in 1880–'83, 117 units of money would have bought as much of grain as 142 units could have done in 1821–'48; but, in respect to labor, it would have required 285 units of money to have bought as much in 1880–'83 as 201 units did in 1821–'48. In respect to cattle, the purchasing power of money had decreased in the ratio of 312 in the latter to 218 in the former period; but since 1879 the carcass price of meats has notably declined in England: inferior beef upon the London market to the extent of 43 per cent (in 1885–'86); prime beef, 18 per cent; pork, 22 per cent; middling mutton, 27 per cent. It is also undoubtedly true, as Mr. John Bright has recently pointed out,† that meat, in common with milk and butter, commands comparatively high prices in England, "because our people, by thousands of families, now eat meat who formerly rarely tasted it, and because our imports of these articles are not sufficient to keep prices at a more moderate rate."

One point of interest pertinent to this discussion, which has for some time attracted the attention of students of social science in England and France, has also been made a matter of comment in the cities of the northwestern United States, especially in St. Paul and Minneapolis, and is probably applicable to all other sections of the country; and that is, that expenditures for rent form at present a much larger item in the living expenses of families than ever before, and for the reason that people are no longer content to live in the same classes of houses as formerly; but demand houses with all of the so-called modern improvements—gas and water and better warming, ventilating, and sanitary arrangements—which must be paid for.

* "Century Magazine," 1887. † Letter to the London "Times," November, 1884.

Reduction in the Hours of Labor.—Concurrently with the general increase in recent years in the amount and purchasing power of money-wages throughout the civilized world, the hours of labor have been also generally reduced. In the case of Great Britain, Mr. Giffen is of the opinion that the reduction during the last fifty years in the textile, house-building, and engineering trades has been at least 20 per cent, and that the British workman now gets from 50 to 100 per cent more money for 20 per cent less work.

In the United States, the data afforded by the census returns of 1880 indicate that in 1830, 81·1 per cent of the recipients of regular wages worked in excess of ten hours per day; but for 1880, the number so working was about 26·5 per cent. In 1830, 13·5 per cent worked in excess of thirteen hours; but in 1880 this ratio had been reduced to 2·5. For the entire country the most common number of hours constituting a day's labor in 1880 was ten.*

That the conclusions of Mr. Giffen respecting the general effect in Great Britain of the increase in wages and reduction in the hours of labor, as above stated, find a correspondence in the United States, might, if space permitted, be shown by a great amount and variety of testimony. A single example—drawn from the experience of the lowest class of labor—is, however, especially worthy of record. In 1860, before the war, the average amount of work expected of spade-laborers on the western divisions of the Erie Canal, in the State of New York, was five cubic yards of earth excavation for each man per day; and for this work the average wages were seventy-five cents per day. At the present time the average daily excavation of each man employed on precisely the same kind of work, and on the same canal, is

* The results of an investigation recently instituted by the Prussian Government in consequence of a demand made for an absolute prohibition of Sunday labor in business occupations in that country, have revealed a curious and apparently an unexpected condition of public sentiment on the subject: Thus from returns obtained from thirty out of thirty-five provinces or departments, containing 500,156 manufacturing establishments and 1,582,591 workmen, it was found that 57·75 per cent of the factories kept at work on Sunday. On the other hand, the larger number of the workmen, or 919,564, rested on Sunday. As regards trade and transportation, it was found that in twenty-nine provinces (out of thirty-five), of 147,318 establishments of one sort or another, employing 245,061 persons, 77 per cent were open on Sunday, and 57 per cent of the employés worked on that day. A canvass of the persons naturally most interested in the matter—i. e., the employés—showed, however, that only a comparatively small number were in favor of the proposed measure. Thus, for example, of those who were consulted in the great factories or stores, only 13 per cent of the employers and 18 per cent of the employed were in favor of total prohibition. In the smaller industries the proportion was 18 per cent of the employers and 21 per cent of the employed. In trade only 41 per cent of the employers and 39 per cent of the employed, and in transportation only 12 per cent of the employers and 16 per cent of the employed, were in favor of total prohibition.

reported as three and a half cubic yards, at a compensation of from $1.50 to $2 per day.

Any review of the recent experiences, in respect to wages and hours of labor, would be imperfect that failed to call attention to the fact that the benefits from advances in the one case, and reductions in the other, have accrued mainly to operatives in factories and to artisans and skilled mechanics, and have been enjoyed in the least degree, and largely not at all, by employés, clerks, book-keepers, copyists, etc., engaged in mercantile and commercial operations and establishments. The reason of this is manifestly that the supply of this latter class of labor has been disproportionately greater than that of the former, and continually tends to be in excess of demand; and, under such circumstances, although the amount of discontent may be, and undoubtedly is, very great and well warranted, the organized and aggressive expression of it finds little sympathy on the part of the public.

The question has been asked, Why is it that wages of manual labor have been constantly rising in recent years, while all other prices have been concurrently falling? or, to put it differently, why is it that overproduction, while cheapening the product, should not also cheapen the work that produces it? The answer is, that the price of the products of labor is not governed by the price of labor, or wages, but that wages, or earnings, are results of production, and not conditions precedent. Wages, as a rule, are paid out of product. If production is small, no employer can afford to pay high wages; but if, on the contrary, it is large, and measured in terms of labor is of low cost—which conditions are eminently characteristic of the modern methods of production—the employer is not only enabled to pay high wages, but will, in fact, be obliged to do so, in order to obtain what is really the cheapest (in the sense of the most efficient) labor. The world has not yet come to recognize it, but it is nevertheless an economic axiom, that the invariable concomitant of high wages and the skilled use of machinery is a low cost of production and a large consumption. In the first of the results is to be found the explanation for the continually increasing tendency of wages to advance; in the second, an explanation why the supplanting of labor by machinery has not been generally more disastrous. If, however, it be rejoined that "the *comparative* poverty of cotton- and woolen-mill operatives, and of women who run sewing-machines," and the like, does not sustain the above explanations, the question is pertinent, Comparative with what? For, low and insufficient as may be the wages of all this class of operatives, they were never, in comparison with other times, so high as at present.

IMPAIRMENT OF THE VALUE OF CAPITAL RELATIVELY TO LABOR.—While the remuneration of labor has enormously increased during recent years, the return to capital has not been in any way proportionate, and is apparently growing smaller and smaller. For this economic phenomenon there can be but one general explanation; and that is, that regarding labor and capital as commodities, or better, as instrumentalities employed in the work of production and distribution, capital has become relatively more abundant than labor, and has accumulated faster than it can be profitably invested; and, in accordance with the law of supply and demand, the compensation for its use—interest or profits—has necessarily declined as compared with the compensation paid for labor.*

One efficient cause of this greater abundance of capital is, that every new invention or discovery produces always as much, and often a much greater amount, of product on a less amount of capital than was previously invested. The result of material progress is, therefore, to supplement the need, or economize the use of capital, and at the same time increase it. For example, a first-class iron freighting screw-steamer cost in Great Britain, in 1872–'74, $90 (£18) per ton. In 1887 a better steamer, constructed of steel, fitted with triple compound engines, with largely increased carrying capacity, and consequent earning power, and capable of being worked at much less expense, could have been furnished for $35 (£7) per ton. How rapidly capital has accumulated in recent years under the new conditions of production is indicated by the circumstance that, although most of the great loans which have been negotiated within the last twenty-five

* The position has been taken, by some investigators and writers, that the great decline in the value of capital—by reason of an impairment of the ability of its owners, i. e., through loss of dividends on investments and of profits in business, to purchase and consume the products of labor, and a diversion of capital, from lack of remunerative income-yielding investments, into enterprises not needed and so occasioning overproduction—has been a prime and perhaps the main cause of all the economic disturbances in recent years. That such a factor, in common with many others, has been instrumental in occasioning serious disturbances, may not be questioned; but that its influence has not been in any sense primary would seem evident, when it is considered that the reason why capital has increased and cheapened in these latter years is, that mankind, through a larger knowledge and better use of the forces of Nature, has been enabled to produce, and actually has produced, a far greater abundance of almost all material things (or, in other words, a greater abundance of capital) than at any former period of their history. Capital, at the outset, greatly contributed to such a development, or, like the wizard in the Eastern fable, it pronounced the incantation which set the natural forces at work; but the wonderful increase and consequent impairment in the value of capital was an after-result, something not anticipated, and the continued progress of which the owners of capital, like the enchanter, now find themselves powerless to check. The saving in the cost of the freight moved on the railroads of every country, comparing 1887 with 1850, and assuming like quantities to have been transported at the different periods, would represent every year more than the original cost of the railroads and their equipment.

years have been for the replacement of capital unproductively used up, or absolutely destroyed in war or military operations, and notwithstanding the immense amount of capital that has also been destroyed during the same period by the replacement of machinery contingent on new inventions, the vacuum thus created has not only been promptly filled, but the competition for the privilege of furnishing further supplies of capital for similar purposes was never greater.

Again, as capital increases and competition between its owners for its profitable investment becomes more intense, and as modern methods can bring all the unemployed capital of the world within a few hours of the world's great centers for financial supply, the rate of profit, or interest to be obtained by the investor or lender, from this cause, also necessarily tends to shrink toward a minimum. Such a minimum will be reached "when the returns for the use of capital become insufficient to induce individuals to save it, especially in the form of its representative, money, and thus add to the available reserves by which expanding industries can be supported." And to such a minimum the financial world seems to be always moving by the force of laws which no combination of capitalists can resist.*

* Those not familiar with financial experiences can hardly realize the great decline within the last few years in the price and profits of capital. Thus, the average rates of interest in the cities of Boston, New York, Philadelphia, Cincinnati, St. Louis, and Chicago, as computed from the record of public transactions, from 1844 to 1858, was 10·5 per cent. In 1871 the London "Economist" estimated that the average rate of interest on a majority of the foreign and colonial stocks and bonds at that time held in Great Britain, amounting to not less than twenty-eight hundred and fifty million dollars, was equal to six or seven per cent as a minimum. Up to 1871 the United States had not been able to sell any portion of its funded debt, bearing 6 per cent gold interest in European markets, on terms as favorable as par in gold, United States five-twenty 6s being quoted on the London market in 1870 as low as 87½. The following is a transcript of the prices of various securities as quoted on the London market in 1871: German Confederation obligations, 5 per cents, 87; French national defense 6s, 87; Massachusetts 5s, 91; Georgia 7s, 78; Spanish 5 per cents, secured by a mortgage on the celebrated quicksilver-mines of New Almaden, in addition to the faith of the Government, 76 and 77; Italian 6 per cents, secured by a pledge of the state revenues from tobacco, 87¾; Japanese 9 per cents, 89; Panama Railroad 7 per cent general mortgage, 93; Michigan Central Railroad, first-mortgage sinking-fund, 8 per cent, 85; Pennsylvania Railroad 6 per cent general mortgage (sterling), 91. To-day the Governments of Great Britain and the United States can readily borrow money at 2½ per cent; all first-class railroad corporations at 4 per cent; while millions of money have been loaned in recent years on real-estate security in the United States for 4 per cent, and in Great Britain for 3 per cent. In Germany the market rate of discount for a considerable period in 1887 was as low as from 1½ to 1⅝ per cent. Not many years ago the customary rate of interest allowed by the savings-banks and trust companies of the United States was 6 per cent; now the former for the most part pay but 4, and the trust companies but 2 to 3 per cent. British consuls in November, 1887, paid to the investor 2$\frac{15}{16}$ per cent, while of the best (debenture) railroad stocks of Great Britain none now return as much as 4 per cent on their current market prices. The dividends of the Imperial (Reichbank) Bank of Germany in

To those who are the possessors of large properties, a gradually diminishing rate of return for the use of capital makes but little difference so far as personal comforts are concerned; but to the small capitalists the steady reduction in income which has been experienced in recent years means always discomfort, and often misery. A striking illustration of this, derived from actual experience, and contingent on a reduction by the Prussian Government of the interest on its debt to 3½ and 3 per cent, is thus given by a recent correspondent (1887) of the London "Economist":

"This reduction," he says, "struck a heavy blow at the existence of what may be called the 'middle classes' in Germany—that is, the great number of people who own a small capital invested in funds, besides carrying on some business or having some other profession. The combined income from both enabled them to live in fair style, making both ends meet by way of carefully regulated expenditure. These classes have formed for over half a century the 'backbone' of Germany. They are now gradually disappearing, making room for great wealth on one side and great poverty on the other."

Decline in Land-Values.—Another interesting and curious feature of the existing economic condition—the direct outcome of the recent radical changes in the methods of production and distribution—has been the decline in the value of land over large areas of the earth's surface. Thus, in the case of Great Britain, while every other item of national wealth has shown an increase —often most extraordinary—since 1840, the estimated value of land in the United Kingdom since that date has heavily decreased.* A similar experience is also reported as respects France,

the four years from 1883 to 1886 inclusive, declined 0·96 per cent, and the average of the private banks of Germany during the same period, 1·60 per cent; all of which clearly indicates that the banking business of Germany is becoming less and less profitable.

* According to Mr. Mulhall, the English statistician, the following table exhibits the changes in the leading items of wealth in Great Britain since 1840:

[Omitting 6 ciphers.]

	1840.	1860.	1887.
Railways	£21	£348	£831
Houses	770	1,164	2,640
Furniture	385	582	1,320
Lands	1,680	1,840	1,542
Cattle, etc.	380	460	414
Shipping	23	44	130
Merchandise	70	190	321
Bullion	61	105	143
Sundries	710	827	1,869
Total	£4,100	£5,560	£9,210

In 1837 the population of the United Kingdom was 26,000,000; in 1887, it was 37,000,000, an increase during the period of 42 per cent.

Germany,* and Portugal. In the latter country, the owners and cultivators of the soil seem to be in a remarkably unfortunate condition. The Portuguese farmer, despite heavy protective duties, finds himself unable to successfully contend with the increased import of cereals, mainly from the United States. The olive-oil industry, formerly flourishing, is so no longer, through the alleged extensive use of American cotton-seed oil as a substitute; while the demand for Portuguese wines, which for a time was increased by the bad vintages of France, is being impaired, and possibly threatened with destruction, by the continually increasing supply in the French markets of cheaper and more suitable wines for mixing purposes from California, the Cape of Good Hope, and Australia. In addition, the copper-mines of Portugal have suffered severely in recent years from the cheaper supplies of American copper. In the Canary Islands, where the soil is most cheap and fertile, and the vegetation of both the tropic and temperate zones flourishes in great luxuriance, the land question has also become of as much importance and embarrassment as in less favored countries. The former great remunerative industry of these islands was wine, "canary"; but this, by the impairment of the vines, has become of little account. These islands also formerly furnished the world with a large supply of cochineal, for the production of which they have special advantages; but since, through the discovery and use of aniline dyes, cochineal, which was once worth $1.75 (7*s.*), will now command but 12 cents (sixpence), this industry has become depressed. Curiously, also, a comparatively extensive export of potatoes from these islands to the Spanish West Indies is diminishing through a competitive exportation of the same vegetable from the United States. So that there seems to be nothing left for the land proprietors and cultivators in this locality to do, except to resort to the method, so much in favor at the present time, of taxing each other for their mutual benefit! Over large portions of the West India Islands, great quantities of excellent land, advantageously situated as regards facility of communication with other countries, under exceptionally healthy climatic conditions, and much of which has been formerly under high cultivation, has been absolutely abandoned, or is in the rapid

* One of the largest landholders of Austrian Silesia thus recently expressed himself: "A few years ago my estates admitted of the profitable cultivation of wheat; but the price of wheat, through the competitive supplies of the United States, and in spite of high protective duties at home, has declined to such an extent that the cultivation is no longer profitable. The same is true in respect to the domestic (Austrian) growing of cattle. Latterly, the encouragement of the beet-root sugar production, by the granting of bounties by the state on its exportation, has given an opportunity for labor and proved remunerative; but if the state should abandon the bounty system, which is not improbable, my land, as a source of income, seems likely to become valueless."

progress of abandonment. In the United States, the decline in the value of land has, in many instances, been also very notable. In the New England States at the present time, agricultural land, not remote from large centers of population, can often be bought for a smaller price than fifty years ago would have been regarded as a fair appraisal, and even less than the cost of the buildings and walls at present upon it. Since the last decennial appraisal of real estate in Ohio (in 1880) "there has been a heavy decline. Farm property is from 25 to 50 per cent cheaper to-day than it then was."* "In the ten cotton States, the value of agricultural land was in 1860 $1,478,000,000; in 1880, $1,019,000,000, a decrease of $459,000,000. It would require an addition of 45 per cent of its value in 1880 to raise it to its value in 1860." Meanwhile, the population of these same States has increased 53 per cent. "In 1860, the value per acre of improved land in Georgia was $6; in 1886, below $3.50; decrease, $2.50. Were the agricultural land divided out among the people, the value per head would have been: in 1860, $150; in 1886, $63; decrease, $87."†

In the foregoing series of papers an attempt has been made to trace out and exhibit in something like regular order the causes and the extent of the industrial and social changes and accompanying disturbances which have especially characterized the last fifteen or twenty-five years of the world's history. The idea adopted at the outset, and an adherence to which has subsequently been kept constantly in view, has been to relate simply but comprehensively what has happened, and thus prepare the way for a solution of the many problems of interest and importance which are the outcome of the situation, rather than attempt the more difficult and to some extent (at present) impossible task of directly formulating and offering satisfactory answers or explanations. At the same time the presentation of whatever in the way of deduction from the record of experience has seemed legitimate and likely to aid in the determination of correct conclusions has not been disregarded, and with a view of further contributing to such results the following additional considerations are finally submitted:

It seems clear that the first and most essential thing for all those who are desirous of determining the extent of the evils which the recent economic disturbances have occasioned, and what course of procedure on the part of society and individuals is likely to prove most remedial of them, is to endeavor to un-

* "Inaugural Address of Governor Foraker," January, 1887.

† Report of a committee of citizens of the ten cotton-growing States ("Sam" Barnett, of Georgia, chairman), "On the Causes of the Depressed Condition of Agriculture, and the Remedies," 1887.

derstand the situation as an *entirety;* and that effort is likely to be rendered ineffectual and disturbance intensified by all discussions and actions that start from any other basis. In fact, one of the remarkable features of the situation has been the tendency of many of the best of men in all countries to rush, as it were, to the front, and, appalled by some of the revelations which economic investigations everywhere reveal, and with the emotional largely predominating over their perceptive and reasoning faculties, to proclaim that civilization is a failure, or that something ought immediately to be done, and more especially by the state, without any very clear or definite idea of what can be done, or with any well-considered and practical method of doing. The position of the Russian novelist Tolstoi, before noticed, is a case in point. The distressing picture of what the world has come to during the fifty years of the reign of Queen Victoria, as drawn by the poet Tennyson in his new "Locksley Hall," and which Mr. Gladstone has so impressively reviewed and effectually disproved, is another. On the other hand, it may be confidently asserted that a comprehensive view of the situation will show that not an evil referable to recent economic changes or disturbances can be cited, which has not been attended with much in the way of alleviation or compensation, the comparison being between individuals and classes and society as a whole. Thus, the facts in relation to the wages earned by the poor men and women who work for the sellers of cheap clothing, and who seem to be unable to find any more remunerative occupations, are indeed pitiful; but, if clothes were not thus made cheap, many would be clothed far more poorly than they now are, or possibly not at all. It is not the rich man who buys "slop" coats and shirts, but the man who, if he could not be thus supplied, would go ragged or without them. If the decline in the price of cereals and in the value of arable land has forced many who follow agricultural pursuits out of employment, there never was a time in the history of the world when the mass of mankind was fed so abundantly and so cheaply as at present. If the decline in the rates of interest on capital has been a sore grievance to the small capitalists, a reduction in the rate of income from invested property means in the final analysis that the world pays less than it has before for the use of its machinery, and that labor is obtaining a "larger" and capital a "smaller" share of the compensation paid for production.

Inequality in the distribution of wealth seems to many to constitute the greatest of all social evils. But, great as may be the evils that are attendant on such a condition of things, the evils resulting from an equality of wealth would undoubtedly be much greater. Dissatisfaction with one's condition is the

motive power of all human progress,* and there is no such incentive for individual exertion as the apprehension of prospective want. "If everybody was content with his situation, or if everybody believed that no improvement of his condition was possible, the state of the world would be that of torpor," or even worse, for society is so constituted that it can not for any length of time remain stationary, and, if it does not continually advance, it is sure to retrograde.†

It is a matter of regret that those who declaim most loudly against the inequalities in the distribution of wealth, and are ready with schemes for the more "equal division of unequal earnings" as remedies against suffering, are the ones who seem to have the least appreciation of the positive fact, that most of the suffering which the human race endures is the result of causes which are entirely within the province of individual human nature to prevent, and that, therefore, reformation of the individual is something more important than the reformation of society.

To understand the problem of poverty, as it at present exhibits itself, especially with reference to remedial effects, it is necessary to look at it comprehensively from two different standpoints. Viewed from the standpoint of twenty or twenty-five years ago, or before what may be termed the advent of the "ma-

* "The incentives of progress are the desires inherent in human nature—the *desire* to gratify the *wants* of the animal nature, the *wants* of the intellectual nature, and the *wants* of the sympathetic nature—*desires* that, short of infinity, can never be satisfied, as they grow by what they feed on."—HENRY GEORGE.

† The conditions which are naturally imbedded, as it were, in human nature, and which war against the realization of the idea of an ultimate equality in the distribution or possession of capital, have been thus clearly and forcibly pointed out by Mr. George Baden Powell in his "New Homes for the Old Country," published in 1872 after a visit to Australia and New Zealand: "Since the arrival of man in the world there have been perpetual questionings as to why all men are not well off. Why should the good things of this life be so unequally distributed? The two great causes, one as powerful as the other, are *circumstances* and *talents*. But these two opposite causes all through man's life influence each other greatly. Circumstances call forth peculiar talents which might otherwise be uselessly dormant, and talents often take advantage of peculiar circumstances which might otherwise be overlooked and missed. It is by no means improbable that as the world grows wiser some means will be found of considerably raising the lowest stage of existence, but *it is entirely against the nature of things that all should be equal in every way*. Innate pride continually urges men to seek that which is above them, and to many happiness in life is the mere gaining of such successive steps. The essential rule is to work one's own circumstances to the highest point attainable by means of the talents possessed. These talents may be said to resolve themselves into various capitals, and a man may have capital for the improvement of his condition in the form of money, brains, or health and strength—in fact, he may thrive by the possession of 'talents,' whether of gold, of the mind, or of the body. With this fully recognized fact of the diversities of capital, it would seem obviously *impossible for a people to continue long in the humanly imposed possession of equal personal shares in any capital.*"

chinery epoch," there is no evidence that the aggregate of poverty in the world is increasing, but much that proves to the contrary. The marked prolongation of human life, or the decline in the average death-rate in all countries of high civilization; the recognized large increase in such countries in the per capita consumption of all food-products; and the further fact that fluctuations in trade and industry, calamitous as they still are, are less in recent times than they used to be, and less disastrous on the whole in their effects on the masses, are absolutely conclusive on this point. Great as has been the depression of business since 1873, there is no evidence that it has yet made any impression on the "stored wealth" of the people of the great commercial countries; and that, slow as is the accumulation of capital, a year probably now never passes in which some addition is not made to the previous sum of the world's material resources. The recognized tendency of the poor to crowd more and more into the great centers of population—drawn thither, undoubtedly, in no small part by the charities which are there especially to be found, and also by the fact that town labor is better paid than country labor—and the contrasts of social conditions, which exhibit themselves more strikingly at such centers than elsewhere, naturally cause popular observation of poverty to continually center, as it were, at its focus of greatest intensity, and creates impressions and induces conclusions that broader and more systematized inspections often fail to substantiate.* Indeed, one thing which the public needs to recognize more fully than it does is, that in most of the leading nations, systematic and rigid investigations, in respect to most economic subjects and questions, have now been prosecuted for a considerable period by governments and individuals; that the broad general conclusions deducible therefrom in respect to mortality, health, wages, prices, pauperism, population, and the like,

* A chapter from the recent experience of the city of Brooklyn, New York, in respect to pauperism, affords a very striking illustration of this statement. In the five years from 1874 to 1878 inclusive, the number of persons who asked and received outside poor relief from the city authorities increased more than 50 per cent, while the increase in the population of the city during the same period was less than 14 per cent. The evidence would, therefore, almost seem conclusive that the masses of this city were rapidly becoming poorer and poorer. In the latter year, however, the system of giving outside poor relief was wholly discontinued. It was feared by many that this action would lead to great distress and suffering, and many charitable persons made preparations to meet the demands they expected would be made upon them. Nothing of the kind occurred. Not only was the whole number (46,093) drawing aid from the county wholly stopped, but it was also accompanied by a decreased demand on the public institutions and private relief societies of the city, and a reduction in the number of inmates in the almshouse. The teaching of this experience, which has since been elsewhere substantiated, is, therefore, to the effect that what seem to be unmistakable proofs of increasing poverty were merely methods to supplement wages on the gains from mendicancy.

are not open to anything like reasonable doubt or suspicion; and also that the pessimistic views which many entertain as to the future of humanity are often directly due to the exposure of bad social conditions which have been made in course of these investigations with the purpose of amending them.

During the last quarter of a century the problem of poverty has, however, been complicated by a new factor; namely, the displacement of common labor by machinery, which has been greater than ever before in one generation or in one country. To what extent the numbers of the helpless poor have been increased from this cause is not definitely known; but the popular idea is doubtless a greatly exaggerated one. In fact, considering the number and extent of the agencies that have been operative, it is a matter of wonderment that the influences in this direction have not been greater. In the United States little or no evidence has yet been presented that there has been any increase in poverty from this cause.* In London, where the cry of distress is at present especially loud and deep, it is "noteworthy that no measures have yet been taken to ascertain whether that distress is normal or abnormal, and whether it is increasing or decreasing." † But even here the opinion, based on what is claimed to be an exhaustive inquiry, has been expressed that, "although the number of those who are both capable and willing to give fair work for fair pay and are at the same time destitute, is in the aggregate considerable, they yet form but a very small proportion of the unemployed"; and "that probably not over two per cent of the destitute are persons of good character as well as of average ability in their trades." ‡ The following additional facts, of a more general nature, are

* According to the Report of the Bureau of Statistics of Labor for Massachusetts for 1887, the whole number of persons of both sexes in that State, who were unemployed at their principal occupation during some part of the year preceding the date of the census enumeration (May 1, 1885), was 241,589, of whom 178,628 were males and 69,961 were females. Comparing these figures with those of the population in 1885, viz., 1,941,465, it is found that for every 8·04 persons there was one person unemployed for some part of the year at his or her principal occupation, the percentage of unemployed being greater in the case of males and less in the case of females. These conclusions, however, throw no light on the number of persons who were unemployed by reasons of displacement by machinery; and are also likely to mislead, unless sufficient consideration is given to the fact that the number of industrial occupations which only admit of being prosecuted during a portion of the year is in every community very considerable. And, as a matter of fact, the investigations in question show that there were only 882 persons representing hardly more than one-third of one per cent of the whole number of the unemployed in this State, who were returned as having been unemployed during the entire twelve months.

† "The Distress in London," "Fortnightly Review," London, January, 1888.

‡ "The Workless, the Thriftless, and the Worthless," "Contemporary Review," London, January, 1888.

also pertinent to this subject: That wages everywhere have not fallen but advanced, as a sequence to the introduction and use of cheaper and better machinery and processes, proves that labor, through various causes—probably by reason mainly of increased consumption—has not yet been supplanted or economized by such changes to a sufficient extent to reduce wages through any competition of the unemployed. The multiplicity and continuance of strikes, and the difficulty experienced in filling the places of strikers with a desirable quality of labor, are also evidence that the supply of skilled labor in almost every department of industry is rather scarce than abundant. Again, it is a matter of general experience that when, in recent years, wages, by reason of a depression of prices, have been reduced in any specialty of production, such reductions have been mainly temporary, and are rarely, if ever, equal to the fall in the prices of the articles produced; which in turn signifies that the loss contingent on such reductions has been mainly borne by capital in the shape of diminished profits. Notwithstanding this, it must be admitted that the immense changes in recent years in the conditions of production and distribution have considerably augmented—especially from the ranks of unskilled labor and from agricultural occupations—the number of those who have a rightful claim on the world's help and sympathy. That this increase is temporary in its nature, and not permanent, and that relief will ultimately come, and mainly through an adjustment of affairs to the new conditions, by a process of industrial evolution, there is much reason to believe. But, pending the interval or necessary period for adjustment, the problem of what to do to prevent a mass of adults, whose previous education has not qualified them for taking advantages of the new opportunities which material progress offers to them, from sinking into wretchedness and perhaps permanent poverty, is a serious one, and one not easy to answer.

A comprehensive review of the relations of machinery to wages, by those who by reason of special investigations are competent to judge, has led to the following conclusions: When machinery is first introduced it is imperfect, and requires a high grade of workmen to successfully operate it; and these for a time earn exceptionally high wages. As time goes on, and the machinery is made more perfect and automatic, the previous skill called for goes up to better work and even better pay. Then those who could not at the outset have operated the machinery at all, are now called in; and at higher wages than they had earned before (although less than was paid to their predecessors), they do the work. Capital in developing and applying machinery may, therefore, be fairly regarded as in the nature of

a force, unintentionally, but of necessity, continually operating to raise all industrial effort to higher and better conditions: and herein we have an explanation of the economic phenomenon that, while the introduction of improved machinery economizes and supplements labor, it rarely or never reduces wages.

One of the most curious features of the existing economic situation is the advocacy of the idea, and the degree of popular favor which has been extended to it, that a reduction of the hours of labor, enforced, if needs be, by statute, is a "natural means for increasing wages and promoting progress."* This movement in favor of a shorter day of work is not, however, of recent origin, inasmuch as it has greatly commended itself to public sentiment in Great Britain and in the United States for many years, and more recently in a lesser degree in the states of continental Europe. But it is desirable to recognize that the early agitation in furtherance of this object, and the success which has attended it, was based on reasons very different from those which underlie the arguments of to-day. Thus, in England and on the Continent, the various factory acts by which the day's labor has been shortened, were secured by appealing to the moral sense of the community to check the overworking of women and children; or, in other words, most of such legislation has thus far been influenced by moral considerations, and has so commended itself by its results that there is probably no difference of opinion in civilized countries as to its desirability. But the form which this movement has of late assumed is entirely different. It is now economic, and not moral, and its final analysis is based on the assumption that the laborer can obtain more of wealth or comfort by working less.

It would seem to need no elaborate argument to demonstrate the absurdity of this position. Production must precede consumption and enjoyment, and the only way in which the ability of everybody to consume and enjoy can be increased, is by increasing, so to speak, the output of the whole human family. If production be increased, the worker will necessarily receive a larger return; if diminished, he will necessarily get a smaller return. And it makes no difference whether the diminution be effected by reduction in the hours of work, or by less effective work, or by disuse of labor-saving machinery, or by other obstructive agencies. The result will inevitably be the same: there will be less to divide among the producers after the constantly diminishing returns of capital have been withdrawn.

It will doubtless be urged that man's knowledge and control of the forces of Nature have increased to such an extent in recent years that almost any given industrial result can now be

* "Wealth and Progress," by George Gunton. D. Appleton & Co., New York.

effected with much less of physical effort than at any former period; and therefore a general and arbitrary reduction of the hours of labor, independent of what has already occurred and is further likely to occur through the quiet influence of natural agencies, is not only justifiable, but every way practicable. This would undoubtedly be true if mankind were content to live as their fathers did. But they are not so content. They want more, and this want is so progressive, that the satisfactions of to-day almost cease to be satisfactions on the morrow. But what "more" of abundance, comfort, and even luxury to the masses has been achieved—and its aggregate has not been small—has not been brought about by any diminution of labor, but has been due mainly to the fact that the labor set free by the utilization of natural forces has been re-employed, as it were, to produce them; or, in other words, recent material progress is more correctly defined by saying, that it consists in the attainment of greater results with a given expenditure of labor, rather than the attainment of former results with a diminished expenditure. Whether the present relation of production to consumption which it now seems necessary should be maintained, if the present status of abundance, wages, and prices is to be continued and further progress made, can be maintained with a diminished amount of labor, may not at present admit of a satisfactory answer. Production in excess of current demand, or overproduction, which has been and still is a feature of certain departments of industry, and which may seem to favor an affirmative answer, is certain to be a temporary factor, for nothing will long continue to be produced unless there is a demand for it at remunerative prices from those possessed of means to purchase and consume, and therefore can not be legitimately taken into account in forming an opinion on this subject; but, other than this, all available evidence indicates that the answer must be still in the negative. Thus, for example, the latest results of investigation by the Massachusetts Bureau of Labor Statistics show that during the year 1885 all the products of manufacture in that State could have been secured by steady work for 307 *working* days of 9·04 hours each, if this steady work could have been distributed equally among all the persons engaged in manufactures. But, to effect such an equitable distribution is at present almost impossible; and if it could be brought about, a reduction of the hours of labor to eight per day in such industries, as has been advocated by many, would reduce the present annual product of Massachusetts to the extent of more than one ninth. Apart, therefore, from the disastrous competition which would be invited from other States and countries where labor was more productive, to expect that under such a reduc-

tion of product the share at present apportioned to the workers, or, what is the same thing, the existing rates of wages could be maintained, seems utterly preposterous. It is not even too much to say that the very existence of multitudes would be endangered if the present energy of production were diminished twenty per cent. And in this connection how full of meaning is the following deduction which Mr. Atkinson finds warranted by investigation, namely: "That over a thousand millions' worth of product must be added every year and prices be maintained where they now are, in order that each person in the United States may have five cents more than he now does, or in order that each person engaged in any kind of gainful occupation may be able to obtain an increase in the rate of wages of fifteen cents a day. Great and undoubted, therefore, as have been the benefits accruing from machinery and labor-saving inventions, the margin that would needs be traversed in order to completely neutralize them by rendering human labor less efficient, is obviously a very narrow one." To which may be added that there is probably no country at the present time where the entire accumulated property would sell for enough to subsist its population in a frugal manner for a longer space than three years.

The greatest of the gains that have accrued to the masses through recent material progress has been in the saving of their time; not so much in the sense of diminishing their hours of labor, as in affording them a greater opportunity for individual self-advancement than has ever before been possible. To clearly comprehend this proposition, it is necessary to keep in view the fact that all men, with the exception of the comparatively few who inherit a competence, are born, as it were, into a condition of natural bondage or servitude. Bondage and servitude to what? To the necessity of earning their living by hard and continuous toil. "In the sweat of thy brow shalt thou eat bread," has been recorded as a divine injunction, and experience shows that a great majority of mankind, as the result of long years of toil, have never hitherto been able to command much more than a bare subsistence. In countries of even the highest civilization, where the accumulation of wealth is greatest and most equably divided, investigation has also led to the conclusion that ninety per cent at least of the population are never possessed of sufficient property at the time of their demise to require the services of an administrator.

Now if, in the course of events, it has become possible, through a greater knowledge and control of the forces of Nature, to gain an average subsistence with much less of physical effort than ever before, what is the prospect thereby held out to the multitude,

who, to secure as much, have heretofore been compelled to toil as long as strength and years would permit? The answer is, the certain prospect of emancipation from such unfavorable conditions. Thus, if eight-hours' labor will now give to an individual the subsistence or living, for the attainment of which ten, twelve, fourteen, or even more hours of labor were formerly (but not remotely) necessary, intelligent self-interest would seem to dictate to him to work eight hours on account of subsistence, and then as many more hours as opportunity or strength will permit; and out of the gain for all such work not required by necessity, purchase his emancipation from toil before age has crippled his energies; or, if he prefers, let him surround himself as he lives, in a continually increasing proportion, with all those additional elements—material and intellectual—that make life better worth living. And, through the rapid withdrawals from the ranks of competitive labor, or the increased demand for the products of labor that would be thus occasioned, the number of the unemployed, by reason of lack of opportunity to labor, would be reduced to a minimum. And that these possibilities are already recognized and accepted by not a few of the great body of workers, is proved by the fact that the greater the opportunity to work by the piece, and the greater the latitude afforded to workmen to control their own time in connection with earnings, the greater the disinclination to diminish the hours of labor.* "No man," says a distinguished American, who from small beginnings has risen to high position, "ever achieved eminence who commenced by reducing his hours of labor to the smallest number per day, and no man ever worked very hard and attained fortune who did not look back on his working days as the happiest of his life." †

* A recent writer, in describing certain factories in New England, where the work is mainly of this character, says: "The days are long for 'piece-work,' and the busy employés are indifferent to eight-hour rules. They reserve only light enough to find their way home, and at twilight they take up their line of march. At present they are earning from three to five dollars per day, according to their capacity." But, as illustrating further how labor treats labor, it is added: "The employés are union men, and they will not allow a single non-unionist to work; neither will they permit any boy under sixteen, or any man over twenty-one years of age, to learn the trade."

† Another, whose life-experience has been similar, also thus aptly states the case: "I have often wondered how workers expect to get on upon eight hours a day. I can not do it. I have worked year after year twelve hours a day, and I know men in my vocation who have done so fourteen hours—not for eight hours' pay, but for fourteen hours' pay. Let a man who is getting day wages for day's work consider how many hours there are in the day. Suppose the day's work is even ten; allow two for meals—that makes twelve; allow nine for sleep and dressing, that makes twenty-one. There are three hours a day for getting on. That is clear profit. There is room for more profit to himself in those three hours than the profit to the employer on the ten hours of his working day. Three hours a day is eighteen in the week—nearly the equivalent of two clear days in the week, a hundred days in the year."

The course of events, nevertheless, warrants mankind in expecting that the progress which has been made in recent years in diminishing the necessity for long hours of labor will be continued; but such progress will be permanent and productive of the highest good only so far as it is determined by natural agencies. "If the attempt is made to save the time of the masses by radical and artificial methods, leisure will become license; but, if they can be taught to save their own time, leisure, as already pointed out, will be opportunity."

Probably the most signal feature of the recent economic transitions has been the extensive decline in the prices of most commodities; and as great material interests have been for a time thereby injuriously affected—commodities at reduced valuation not paying the same amount of debt as before—the drift of popular sentiment seems to be to the effect that such a result has been in the nature of a calamity. Accordingly, a great variety of propositions and devices have been brought forward in recent years, and largely occupied the attention of the public in all civilized countries, which, in reality, have had for their object not merely the arrest of this decline, but even the restoration of prices to something like their former level; and in such a category the attempt to regulate artificially the relative values of the precious metals, the increasing restrictions on the freedom of exchanges, the stimulation of trade by bounties, the formation of "trusts," "syndicates," trade and labor organizations, and the like, may all be properly classed. But all such attempts, as Dr. Barth, of Berlin, has expressed it, "are nothing more than designs to lengthen the cloth by shortening the yard-stick." Decline and instability in prices, if occasioned by temporary and artificial agencies, are to be deprecated; but a decline in prices caused by greater economy and effectiveness in manufacture, and greater skill and economy in distribution, in place of being a calamity is a benefit to all, and a certain proof of an advance in civilization. The mere fact that the general fall of prices which has occurred has been attended with an almost simultaneous and universal increase in the consumption of the necessaries of life and other commodities, is conclusive not only of a great improvement in the condition of the masses, but also that all attempts to retard or reverse this movement by governmental interference or individual organizations, are the worst possible economic policy. In Great Britain alone the decline in the price of meats and cereals between 1872 and 1886 is estimated to have resulted in producing an annual saving to each artisan consumer of $1.95 per head in meat and $3.75 per head in wheat, or an aggregate on 25,000,000 consumers of $142,500,000 per annum. At the same time, and very curiously, investiga-

tions seem to prove that the aggregate consumption of wheat and meats in Great Britain has not in recent years increased; but such an unexpected result will probably find an explanation in the circumstance that the undoubted increased earnings of the masses have been directed to the satisfying a desire for many commodities which formerly they could not gratify, rather than an increased consumption of breadstuffs and meat products.

Judged by their fiscal policies, most governments would also seem to regard a decline in prices, especially in respect to food products, as in the nature of a calamity to their people. With the exception of Great Britain and Holland, nearly every nation —pretending to any degree of civilization—has within recent years greatly increased its taxes on its supply of food from without, and more especially on meats and cereals. A comparison of the prices of wheat in England and France for 1886 shows that French consumers paid during that year alone 6*s.* 3*d.* ($1.50) per quarter more than they would need have done for all the wheat used by them as food in the country, had the free importation of wheat into France been permitted, or $38,000,000 on their minimum aggregate consumption for twelve months. In March, 1887, an increase in the French duties on the importation of wheat further increased its price in France to an average of 9*s.* 8*d.* ($2.19) per quarter over the corresponding average rates in England; which difference, if maintained for the ensuing twelve months, would have increased the aggregate cost of bread to French consumers by the large sum of $87,000,000.

In 1885 the registered sales of horse-flesh for human consumption in Paris were 7,662,412 pounds. In 1886 the sales were officially reported as having increased to 9,001,300 pounds, with an accompanying marked diminution in the consumption of pork. Whether there is any necessary connection between the two experiences need not be affirmed, but the facts are suggestive.

The attempt to crush out of use, by legislation, one of the most brilliant discoveries of the age, namely, the manufacture of butter from the fat of the ox, equally as wholesome as that made from the fat (cream) of the cow, is a libel on civilization; and, as a measure for depriving the masses of a better article of desirable food at cheaper rates, than very many of them have been accustomed to have, or can now procure, would be fiercely resented by them, if once properly and popularly understood.*

* A report on the subject of "Oleomargarine," by the Royal Health Department at Munich, submitted March, 1887, says: "This product is made in great part from such proper ingredients as are useful in nourishment, namely, the fats or greases; and therefore it is of importance, as it furnishes to the poorer classes a substitute for butter which is cheaper and at the same time nourishing. We think that this want has been supplied

The fact that in no country do the masses ever experience as much benefit from a fall of prices as they would seem to be fairly entitled to, owing to the great difference between wholesale and retail rates, and that this difference is always greatly intensified in the case of the poor who purchase in small quantities, clearly indicates one of the greatest and as yet least occupied fields for economic and social reform. Flour, in the form of bread, costs usually three times more, when distributed to the poorer consumers in cities of the United States, than the total aggregate cost of growing the wheat out of which it is made, milling it into flour, barreling, and transporting it to the bakeries. The retail prices of meats are enhanced in like manner; and investigation some years ago showed that when anthracite coal was being sold and delivered in New York city for $4.50 per ton, it cost the people on the East and North Rivers, who bought it by the bucketful, from $10 to $14 per ton.

Similar results are noticed in all other countries. Out of every £100 paid by the consumers of milk in London, Sir James Caird estimates that not more than £30 finds its way into the hands of the English dairy farmers who in the first instance supply it. In the case of some varieties of fish—mackerel—the cost of inland distribution in England has been reported to be as high as 400 per cent in excess of the price paid to the fishermen. Eggs collected from the farmers in Normandy are sold according to size to Parisian consumers, at an advance in price of from 82 to 200 per cent.

The payment of rent is believed by many to be the chief cause of social distress, and a continual draught on the resources of the poor, for which no adequate equivalent is returned. And yet investigations similar to those (before noticed) which have demonstrated how small need be the first cost of the food essentials of good living, have also led to the opinion that, "not much more than half the money that men usually pay for rent would, if expended in the right direction and under easily prepared guarantees, secure them possession of good homes, protected in all the rights given by a title in fee simple, and which they could transmit unencumbered to their families."

Co-operative associations have done something in the way of remedying the evils resulting from unfair and unnecessary enhancements of prices to consumers buying at retail or in small quantities; but as yet the success that has attended their efforts in this direction, although promising, has been partial and incomplete. Associations of this character appear to find much

in a most satisfactory manner by the manufacture of artificial butter. And it is offered in the markets in a condition superior to natural butter as far as cleanliness and careful preparation are concerned."

more popular favor and support in England than in the United States; and, probably, for the reason that the great establishments which have sprung up in recent years at almost all the considerable centers of population in the United States for the sale of imperishable commodities, and which are systematically conducted on the economic basis that large sales with relatively small profits ultimately assure the largest aggregate of profits, sell goods of the character indicated at lower retail prices than generally prevail in England, and so limit the sphere of beneficial operation of the American co-operative societies.

The relation between prices and poverty has long attracted attention, and nothing new in the way of theory remains to be offered. Three thousand or more years ago, a certain wise man, who had sat at the marts of trade, and made himself conversant with the nature of wholesale and retail transactions, embodied in the following short and simple sentence as much in the way of explanation of these involved phenomena as the best results of modern science will probably ever be able to offer, namely—"*The destruction of the poor is their poverty.*"—*Proverbs, 10th chapter, 15th verse.* Something in the way of a real contribution to our general understanding of this subject would, however, seem to be found in the recent observation that the value-perceiving sense or faculty is not implanted by Nature in every person, but differs widely in different races and families; and that "he who has it will accumulate wealth with comparatively slight exertion, while he who has it not will not gain it, no matter how energetically he labors."* Illustrations of this are familiar to every student and investigator of social science; but the following one seems especially worthy of record: On the ferries between New York and Brooklyn, the rates of toll were some years ago reduced nearly one half to all who would buy at one time (or at wholesale) fifty cents' worth of tickets. But it was soon noticed that the working-classes, who at morning and evening constituted the bulk of the travel, rarely bought tickets, while they were bought as a rule by those who belonged to banking and mercantile establishments.

The countries of the world which within the last third of the century have made the greatest material progress are the United States and Australia. This has been due largely in both cases to the vast abundance of cheap and fertile land, which has occasioned and made possible a great increase in population. Like conditions have been similarly influential in increasing the population of Russia in a more rapid ratio than in most of the other countries of Europe. The United States, by reason of its great natural resources, and extensive use of machinery and con-

* "The Labor-Value Fallacy," by M. L. Scudder, Chicago, 1886.

sequent ability to control the supply and the price of many of the chief staple articles of the world's consumption—cotton, cereals, meats, tobacco, petroleum, and silver—is at present the great disturbing factor in the world's economic condition. But, of all old countries, England leads in all that pertains to civilization; and, making allowance for the exceptional advantages enjoyed by the United States and Australia, her relative progress has probably been as great as that of any country. In no one of the countries of Europe has the increase of population been greater, and in Italy, Germany, and Russia only, has there been an approximate growth; and this result has been especially remarkable, inasmuch as for many years England has not had an acre of virgin soil to expand upon. In no country of Europe, furthermore, has the increase of population been probably so largely accompanied by an increase in comfort as in England. Forty years ago the United Kingdom owned only about one third of the world's shipping. Now it practically owns more than one half, and of the existing steam-tonnage it owns seventy per cent. In respect to exports and imports—comparisons being made per capita—no other nation approximates England in its results to an extent sufficient to fairly justify a claim in its behalf to even the holding of a second place.*

Something of inference respecting the economic changes of the future may be warranted from a study of the past. It may, for example, be safely predicated that whatever of economic disturbance has been due to a change in the relative value of silver to gold, will ultimately, and probably at no very distant period, be terminated by a restoration of the bullion price of the former metal to the rates (60 to 61 pence per ounce) that prevailed for many years prior to the year 1873. The reasons which warrant such an opinion are briefly as follows:

Silver is the only suitable coin medium for countries of comparatively low prices, low wages, and limited exchanges, like India, China, Central and South America, which represent about three fifths of the population of the world, or about a thousand millions of people. Civilization in most of these countries, through the advent of better means of production and exchange, is rapidly advancing—necessitating a continually increasing demand for silver as money, as well as of iron for tools and machinery. Generations also will pass before the people of such countries will begin to economize money by the use to any extent of its representatives—paper and credit, under such circumstances a scarcity, rather than a superabundant supply of silver, in the world's market, is the outlook for the future; inasmuch as a comparatively small per capita increase in the use of

* Robert Giffen, letters to the London "Times," 1884.

silver by such vast numbers would not only rapidly absorb any existing surplus, but possibly augment demand in excess of any current supply.* The true economic policy of a country like the United States, which is a large producer and seller of silver, would therefore seem to be, to seek to facilitate such a result, by removing all obstacles in the way of commerce between itself and silver-using countries, in order that, through increased traffic and consequent prosperity, the demand for silver on the part of the latter might be promoted.

The great reduction in the cost of transportation of commodities has been one of the most striking features of recent economic history. Produce is now carried from Australia to England, a distance of eleven thousand miles, in less time and at less cost than was required a hundred years ago to convey goods from one extremity of the British Islands to the other. The average cost of transporting each ton of freight one mile on the Pennsylvania Railroad during the year 1887 was $\frac{426}{1000}$ of a cent. At first thought it would seem as if improvement in this sphere of human effort had certainly found a limit; but there are reasons for believing that even greater reductions are possible. Apart from improvements in machinery, and greater economies in operating, very few of the great lines of transportation, especially the railways, have as yet sufficient business to continuously exhaust their carrying capacity; but, when this is effected, and the present large class of fixed expenditures is apportioned to a larger business, lower rates for freight, from this cause alone, will be permissible; all of which, however, is simply equivalent to reaffirming the old trade maxim that it costs proportionally less to do a large than a small business.

An anticipation of an immense increase in the near future, in the commerce between the countries of the western and eastern hemispheres, owing especially to the introduction into the latter of better methods for effecting exchanges and transmitting in-

* According to statements submitted to the Royal (English) Commission on Trade Depression, "The quantity of pure silver used for coinage purposes, during the fourteen years ending 1884, was about eighteen per cent greater than the total production during that period; and there are other estimates which place the consumption at a still higher figure. It is to be remembered that the coinage demand is fed from other sources than the annual output of the mines. It is supplied to some extent by the melting down of old coinage. Allowing for this, however, the evidence of statistics goes to show that the coinage demand for the metal is, and has been, sufficient to absorb the whole of the annual supply that is left free after the consumption in the arts and manufactures has been supplied; and this conclusion is supported by the fact that nowhere throughout the world has there been any accumulation of uncoined stocks of the metal."—*London Economist.*

The situation suggests what is reported to have been contemplated, namely, the formation of a syndicate—like the so-called recent French syndicate in copper—for intercepting the current market supplies of silver by speculative purchases and vast holdings, with a view of compelling an immediate rise in the bullion price of this metal.

formation, is certainly warranted by recent experiences. Thus, if the trade between the United Kingdom alone and the leading countries of the East, exclusive of India, continues to increase in the next quarter of a century in the same ratio as it has during the last quarter, when commercial facilities were much less than at present, its aggregate value of $190,000,000 in 1860, and $440,000,000 in 1885, will swell to $1,038,000,000 in the year 1910; and, beyond that date, to an amount that must be left to the imagination.

That the only possible future for agriculture, prosecuted for the sake of producing the great staples of food, is to be found in large farms, worked with ample capital, especially in the form of machinery, and with labor organized somewhat after the factory system, is coming to be the opinion of many of the best authorities, both in the United States and Europe. And as a further part of such a system, it is claimed that the farm must be devoted to a specialty, or a few specialties, on the ground that it would be almost as fatal to success to admit mixed farming, as it would be to attempt the production of several kinds of manufactures under one roof and establishment.

Machinery is already largely employed in connection with the drying and canning of fruit and vegetables, and in the manufacture of wine. In the sowing, harvesting, transporting, and milling of wheat, the utilization has reached a point where further improvement would seem to be almost impossible. In the business of slaughtering cattle and hogs, and rendering their resulting products available for food and other useful purposes, the various processes, involving large expenditure and great diversity of labor, especially in "curing," succeed each other with startling rapidity, and are, or can be, all carried on under one roof; and on such a scale of magnitude and with such a degree of economy, that it is said that, if the entire profits of the great slaughtering establishments were limited to the gross receipts from the sale of the beef-tongues in the one case and the pigs' feet in the other, the returns on the capital invested and the business transacted would be eminently satisfactory. It is not, however, so well known that the business of fattening cattle by the so called "factory system," on a most extensive scale, has also been successfuly introduced in the Northwestern and trans-Mississippi States and Territories, and that great firms have at present thousands of cattle gathered under one roof, and undergoing the operation of fattening by the most continuous, effective, and economic processes. The results show that one laborer can take care of two hundred steers undergoing the process of grain-feeding for the shambles, in a systematic, thorough manner, with the expenditure of much less time and labor per day than the

ordinary farmer spends in tending fifteen or twenty head of fattening steers under the disadvantages existing upon ordinary farms. In these mammoth establishments "a steam-engine moves the hay from one large barn to another, as needed, by means of an endless belt, and supplies it to a powerful machine, where it is cut into lengths suitable for feeding, and afterward carries the cut hay by other belts to the mixing-room, where by means of another machine it is mixed with corn-meal; the corn having been previously shelled and then ground on the premises by power from the same engine. Again, the mixed feed is carried automatically to the feed-boxes in the stalls. The same engine pumps the water for drinking, which runs in a long, shallow trough within reach of the steers; and even the stalls are cleaned by water discharged through a hose, the supply being raised by the engine and stored for use. The steers are not removed from the stalls in which they are placed from the time the fattening process is begun until they are ready for transportation to the big establishments above mentioned for systematic slaughtering. The advantages of such establishments are not, moreover, confined to labor-saving expedients merely. The uniformity of temperature secured through all kinds of weather is equivalent to a notable saving of feed; for where fluctuations of temperature are extreme and rapid, and not guarded against, "a great deal of the grain which the farmer feeds is 'blown away' after having been consumed by his stock," in form of vital heat, strength, and growth, which are the products of the conversion of the grain on digestion.*

* It has been found that the present usual method adopted on Western farms of feeding grain, especially corn, without previous grinding, is most costly, as the grain in its natural condition is imperfectly digested. Another serious objection to the imperfect methods of the ordinary farm in grain-feeding is, that the grain is fed in a too concentrated form; the fact being unknown, or disregarded, that the thrift of the fattening animal depends largely on the intimate admixture of ground grain with coarse forage; and that hay, also, must be chopped, and more thoroughly intermingled with it, for the attainment of the best results. But the chopping of the hay and straw and the mixing with meal and water is a laborious operation, and hence the economy of applying the steam-engine, and thus saving labor in the business of feeding. Another saving is in building materials; the larger the structure in which the machinery, the hay and grain, and the animals are kept, the less the proportionate quantity of lumber needed; and then, again, in such an establishment, temperature and ventilation, which in ordinary farming are matters that receive little attention, are economically and effectively regulated. An American practical farmer, the owner and manager of seven thousand acres (Mr. H. H——, of Nebraska), to whom the writer is indebted for many items of information, communicates the following additional review of this subject from the American (Western) stand-point: "The average Western farm is now recklessly managed, but capital will come in greater volume and set up processes which will displace these wasteful methods. The revolution is certain, even if the exact steps can not now be precisely indicated. At present the hay, and much of the grain, and nearly all of the tools and implements, are unsheltered; and more than fifty per cent of the hay is ruined for a like reason, while

How great a revolution in the business of agriculture is yet to be effected by the cultivation of land in large tracts, with the full use of machinery and under the factory system, is matter for the future to reveal; but it can not be doubted that the shiftless, wasteful methods of agriculture, now in practice over enormous areas of the earth's surface, are altogether too barbarous to be much longer tolerated; and, as the result of such progress, the return of the prices of meats and cereals to their former higher rates, which many are anticipating on account of the increasing number of the world's consumers, may be delayed indefinitely. Possibly in the not very remote future, the world —as its population shows no signs of abatement in its increase— may be confronted with a full occupation of all farming land and a great comparative diminution of product through an exhaustion of its elements of fertility; but, before that time arrives, improvements may possibly be made in agriculture which will have practically the same effect as an increase in the quantity of land; or possibly chemistry may be able to produce food by the direct combination of its inorganic elements.

Finally, a comprehensive review of the economic changes of the last quarter of a century, and a careful balancing of what seems to have been good and what seems to have been evil in respect to results, would seem to warrant the following conclusions: That the immense material progress that these changes have entailed has been for mankind in general, movement upward, and not downward; for the better and not for the worse; and that the epoch of time under consideration will hereafter rank in history as one that has had no parallel, but which corresponds in importance with the periods that successively followed the Crusades, the invention of gunpowder, the emancipation of thought through the Reformation, and the invention of the steam-engine; when the whole plane of civilization and

the animals themselves (I do not mean now on the wild-stock ranges, but even on the trans-Missouri farms) have no roof over their heads, except the canopy of heaven, with the mercury going occasionally twenty and even thirty degrees below zero. These wasteful methods in farming are in part promoted by the United States homestead law, and the occupation of the hitherto inexhaustible expanse of cheap lands. When the ignorant, degraded, and impecunious can no longer acquire a hundred and sixty acres upon which to employ their barbarous methods, and when the land already taken up shall have risen from the low prices at which it now stands to fifty dollars or more per acre, a new dispensation will arrive. Neither the cattle, nor the food which the cattle consume, will then be raised by any such methods as now prevail; neither will they be exposed to the elements in winter. True enough, the opening up of other virgin fields in Australia, South America, Africa, and elsewhere, may retard this rise in the value of the land in the western part of our continent, and thus to a certain extent delay the passing of the land exclusively into the hands of larger capitalists and better managers; but it must be considered that not all climates are suitable for energetic, capable farming populations, and likewise that the best forage plants are restricted to temperate latitudes."

humanity rose to a higher level; each great movement being accompanied by social disturbances of great magnitude and serious import, but which experience proved were but temporary in their nature and infinitesimal in their influence for evil in comparison with the good that followed. And what the watchman standing on this higher eminence can now see is, that the time has come when the population of the world commands the means of a comfortable subsistence in a greater degree and with less of effort than ever before; and what he may reasonably expect to see at no very remote period is, the dawn of a day when human poverty will mean more distinctly than ever physical disability, mental incapacity, or unpardonable viciousness or laziness.

THE MORAL INFLUENCE OF CLIMATE.

By FELIX L. OSWALD, M. D.

A PHILOSOPHIC advocate of religious tolerance holds that "the most effective way to explode a popular fallacy is to explain it." If we should apply that method to the exorcism of the mediæval specters that still haunt the by-ways of the nineteenth century, we might say that the moral aberrations of the middle ages sprang chiefly from the *tendency to underrate the moral effects of physical causes.* If the chronic despondency of a mediæval dyspeptic reached the phase of suicidal temptations, his confessor would advise him to defeat the wiles of the arch-fiend by devoting his leisure to the recitation of a few thousand paternosters. If peppered hash and want of exercise had vitiated the temper of his wife to an unbearable degree, he was instructed to consider the visitation a judgment incurred by his unbelief, or by his opposition to an extra assessment of the tithe-collector. The epidemic increase of the alcohol-habit was persistently treated as a disorder amenable to the influence of prayer-meetings. For nearly a thousand years the history of European morals was, indeed, the history of the efforts and failures of visionaries who hoped to reconcile the promotion of ethical reform with a total neglect of physiological studies.

Since the revival of naturalism, however, the tendencies of educational reform make it probable that the progress of moral philosophy will become identified with the development of a new science, thus far only outlined in a few incidental treatises on the *interaction of body and mind.* The possibilities of that science are suggestively indicated by the results of the statistical studies devoted to one of its branches—the moral influence

of climate. Modern French scientists are nothing if not methodical, and have repeatedly called attention to the curious regularity in the geographical distribution of certain vices and virtues: intemperance, for instance, north of the forty-eighth parallel; sexual aberrations south of the forty-fifth; financial extravagance in large seaport towns; thrift in pastoral highland regions. It is, indeed, a remarkable circumstance that in the home of the best wine-grapes, in Greece and southern Spain, drunkenness is far less prevalent than in Scotland, or in Russian Poland, where Bacchus can tempt his votaries only with nauseous *vodka*. The idea that a low temperature begets an instinctive craving for alcoholic tonics seems disproved by the teetotalism of the Patagonian savages, who horsewhip every Spanish stimulant-monger without benefit of clergy. The Lesghian mountaineers, too, observe the interdict of the Koran in the icy summit-regions of the Caucasus; but there is no doubt that the bracing influence of a cold climate affords a certain degree of immunity from the debilitating effect of the alcohol-vice, and that a Scandinavian peasant can for years survive the effects of a daily dose of alcohol that would kill an Egyptian fellah in a single month. But it is equally certain that the temperance of south-land nations is considerably facilitated by the abundance of non-alcoholic pastimes. The Spaniards have their fandangos and bull-fights; the Greeks their border-raids, cocking-mains, and horse-races; while the Scotchman, after six days of hard work, is confronted with the choice between the delirium of an alcohol-fever and the appalling tedium of sabbatarian asceticism, and naturally chooses the less dismal alternative.

The question, though, remains, if religious gloom itself is not an outcome of climatic influences. Cardinal de Retz, indeed, held that orthodox loyalty is a flower that can not flourish north of the Alps; but it is more than probable that the survival of that plant has been greatly assisted by the conniving *bonhomie* of south European ecclesiastics, who, centuries ago, began to appreciate the wisdom of extending the practice of renunciation to the claim of consistency. The "climate of superstition" can not be defined by geographical specifications; but, as the gilded clouds of the South float grizzly over the moping firmament of the North, dogmas which the inhabitants of the lower latitudes manage to reconcile with a good deal of secular beatitude are apt to assume a gloomy character in the land of the hyperboreans, whose rational rigorism, however, may recalcitrate against self-contradictory tenets, and accept a thoroughly uncomfortable more readily than an illogical doctrine. Thus we find the Nahagathas, the Protestants of Buddhism, confined to Japan and northern China, and the schismatic Shiites to the

Islamized highlands of Central Asia. The most obstinate dissenters of the Greek Church have their strongholds in northern Russia, while the heresies of the Cossacks are limited to ultra-convivial celebrations of ecclesiastic holy-days. Even in ancient Greece the South-Hellenic Spartans seem to have been much less heterodox than their North-Hellenic rivals.

The supposed concomitance of low latitudes and low morals—in Origen's sense of the word—is a theory considerably modified by the reports of our latter-day north-pole explorers. Chamisso, Pallas, Adams, Gabriel Sarytchew, and Kane agree that certain tribes of the polar regions are sensual to a degree that would have scandalized the natives of ancient Lesbia, and certainly suffices to amaze the modern Cossacks, who, in their turn, astonish the not over-scrupulous moralists of the Danubian principalities. Among the Yakoots of northern Siberia *mésalliances* of an unmentionable kind are condoned as readily as a still more unprecedented degree of sexual precocity which Chamisso ascribes to the "almost exclusively animal diet of the wretched pygmies." Our equally carnivorous Indians are, however, characterized by a sexual apathy which an able American ethnologist seems inclined to consider a principal cause of their gradual extinction; and Chamisso's hypothesis must probably be supplemented by other explanations—for instance, the enforced idleness of his pygmies during the snow-bound season of short days and overlong nights. Idleness may likewise account for the erotic excesses of islanders enjoying the benefits of a fertile soil and a genial climate, like the notorious natives of various parts of the Grecian Archipelago and the Lesser Antilles, not to mention the *ne plus ultras* described in the reports of the first South Sea explorers. As a rule, the prevalence of incontinence bears an inverse ratio to the predominance of *active* modes of life; in any sense of the word, the continence of hunters and nomads being almost rivaled by that of intensely industrial communities.

Cœteris paribus, however, precocity increases with the distance from the isotherm of Stockholm, about the sixtieth degree of northern latitude in Europe and the forty-fifth degree in the western hemisphere. North of that parallel the stunted and short-lived hyperboreans marry as early as the premature children of the tropics, tropical highland regions generally excepted. The copper-colored natives of the Peruvian *alturas* marry late, while under the same parallel the creoles of the Brazilian lowlands do not hesitate to encourage the matrimonial propensities of children in their earliest teens, boys of fourteen and girls of thirteen and twelve, or, if we shall believe Dr. Burmeister, even of ten and nine. The courtships of Sicily, too, are expeditious,

even from an Italian point of view, while on the island of Corsica a peculiar state of agrarian difficulties has counteracted the influence of climate. Many of the *campanitas* or small terrace-plains have been so utterly exhausted that the available means of irrigation fail to redeem the impoverished soil, while a large percentage of the productive area is in the hands of the convents, which reserve the right of tenure for their old retainers. Combined with the straits of that land-famine, the over-increase of population became such an unqualified evil that the common sense of the peasants originated a system of ostracism, attaching infamy and social excommunication to the preliminaries as well as to the results of marriage before a specified age. In France the enormous burden of taxation has practically led to an identical result, and the prevalence of a mode of existence which Edmond About calls the "celibacy of prudence" is no longer confined to the larger cities.

The late marriage of mountaineers, too, may be partly explained by their instinctive love of independence. The sterile soil of a highland region necessitates far and frequent excursions in quest of the means of subsistence, and the unencumbered privilege of personal freedom thus became often a condition of survival. With a marmot and a hand-organ, if not with a marmot alone, the young Savoyard perambulates Europe from end to end till he has accumulated the equivalent of an Alpine competency. The *monteros* of the upper Apennines roam Italy like gypsies, ready to do any man's harvest-work. Young Scotchmen cross the Tweed or even the Atlantic before they venture to run the risks of matrimony on the precarious resources of a Highland moor. The scantness of population, and the consequent distance from neighbor to neighbor, help to train highlanders in the habits of self-help, and thus form that instinct of independence which has generally justified the proud motto of West Virginia.

A similar cause, however, would seem to have produced a similar result among all true nomads, who likewise are obliged to

"Make each day earn the daily right to live."

But while the patriotism of the Arabs and Turkomans (as well as of the originally nomadic Hebrews) takes the form of an exportable national pride, a sort of hygienic intuition appears to teach mountaineers the superiority of their native climate and make them averse to a permanent change of habitation. Highlanders, though the stoutest defenders of their native soil, have therefore rarely engaged in wars of conquest; and the most *expansive* nations, to use a Bismarckian euphuism, were generally lowlanders—Prussians, Russians, Arabs, Mongols, Goths, and Tartars. We might add Romans, for the tide of conquest which

inundated all the coast-lands of the Mediterranean originally emanated from the plains of Latium; and, if Mr. Katkoff's prognosis should be fulfilled by the disintegration of the American Union, it would be safe to predict that the larger part of our present territory would be reconsolidated by some eupeptic lowland State, Missouri or Michigan, and that the Alleghanies would maintain their independence by the stubborn resistance of their highlanders. The nomadic herders of western Texas, too, might prolong that resistance for many years; but, on the whole, the march of the new empire would follow the course of the Mississippi, for the double reason that the stream of conquest has generally moved seaward and southward. Russia will not rest till her fleet rides the eastern Mediterranean as well as the Euxine. Tamerlane avowedly intended to extend his empire to the Atlantic; and, from the campaigns of King Cyrus to the expansive enterprises of Victor Emanuel, nine out of ten international wars have ended with the victory of northern nations over their southern neighbors. The goddess of fortune would decline to be crowned with a fur cap, and the sun of the south that turns a lynx into a lion does not necessarily reverse the process in the case of the human animal; but it is true that a rigorous climate evolves superior "staying power," and in war the last shout is worth a dozen challenges. The history of Europe might, indeed, encourage the idea that certain northern nations love war for its own sake, though Prof. Vogt informs us that gratuitous combativeness is a sign of specific inferiority. "Ants and wasps that tackle every wayfarer," says he, "can not compete with the species that reserve their energy for serious emergencies, and without the protection of the dog-fancier the breed of bull-dogs would speedily succumb to their preposterous propensities." Waspish aggressiveness would rather seem to be a product of sterile plains, that appear to bristle with stilettos as spontaneously as with cactus-thorns—the brigandage of Turkistan and stony Araby having its exact analogue in the kidnapping and train-robbing rowdyism of our arid Southwest.

Nor is it quite certain that the "instinct of industry" can be considered an exclusive product of the higher latitudes. When all northern Europe was still slouching in bear-skins, Egypt and Phœnicia were buzzing hives of industrial activity. Our North American Indians had only wigwams when Mexico was studded with palaces. But here, too, the virtue of perseverance seems to have prevailed against the talent of initiation, and the energy of the North, once started in the arena of industrial competition, has managed to distance the earlier enterprise of the South.

Civilization, in the modern sense of the word, is, however, to a large extent founded on the activity of the instincts of co-op-

eration and altruism, both of which are undoubtedly stimulated by the emergencies of a rigorous climate. A hard-headed northlander who has himself been snow-bound and frost-bitten will not ignore the distress of a help-needing neighbor; while the religious charity of the Siamese peasant is apt to be modified by the reflection that, after the total loss of their fruit-crop, his storm-stricken brethren in Buddha can still eke out a tolerable living in the woods.

IS COMBINATION CRIME?

By APPLETON MORGAN.

WHEN, a few months ago, announcement was made, in despotic opulence of mural decoration, that Mr. Barnum's and Mr. Forepaugh's circuses had pooled their attractions under a single tent, the American small boy lodged no protest, nor did he invoke the statutes of this republic against the dangers with which its institutions were threatened. But when whisky, or coal, or cotton-seed oil, or prunes, or beeswax, propose to adhere in happy family compact, the occasion is not allowed to pass without jeremiad on the perils of this commonwealth and the departure of the liberties of this people.

In a paper entitled "Modern Feudalism," in the "North American Review" for April, 1887, I understand Mr. James F. Hudson to suggest that any old-fashioned ideas as to the economy of large producers over small ones, and supposed consequential security of wages, greatest good of the greatest number, etc., which may still obtain in the community, are survivals of the dark ages, and without place in the enlightened civilization of this continent; and to assert that any combination of corporations or large manufacturers or producers for manufacture or production of a single staple, which shall purchase the interest or business of smaller manufacturers or producers, is a menacing danger, not only to the consumer, but to the State. Mr. Hudson has nothing to submit as to any possible small competitor who might perhaps be willing or even anxious to be crushed out "for a consideration" rather than assume all the chances of himself crushing out the larger competitor. Nor do I find him discussing the question as to what interest it is to the consumer whether the product he consumes be manufactured or quarried by a small concern or a large one. His propositions, however, are sufficiently startling to the old-fashioned reader of what once was the science of political economy to warrant, I think, a passing notice in the pages of "The Popular Science Monthly."

Mr. Hudson, to begin with, is of opinion that any incorpora-

tion, combination, or "trust" organized for business purposes is a "corner" in the thing manufactured, and therefore against the written law of the land as well as the public interest. He is wrong here at the outset. Everybody who knows anything about the matter knows that to "corner" a product is to raise its price, not to the consumer, but to the operators against whom the "corner" is engineered. However disastrous a "corner" may be to the "shorts" who fight it: ultimately fatal to the schemers (who risk public indignation if they succeed or the prospect of bankruptcy if they fail in sustaining it), I have yet to learn of any permanent injury to the consumer—or to the great body of the people—resulting from the wickedest corner that ever was attempted. Without attempting any palliation of or excuse for the gamblers who stack staples instead of "chips" and shuffle values instead of cards, it is yet, perhaps, proper to suggest that even trusts, combinations, and incorporations for business purposes are of some ultimate good to the community and benefit to the bread-winner; and to point out the actual fact that, so far from raising, it is to the immediate interest of a combination of small business interests into a large one to at once cheapen the prices of its product to the very minimum margin of profit at which manufacture can be carried on. Otherwise, the crop of new combinations to be bought out would be endless. For, surely, so long as the product in which the combination deals can be manufactured at a profit, just so long will there be manufacturers. Mr. Hudson, no doubt, burns gas. But any consumer of illuminating oil can tell him that he can buy from an agent of Mr. Hudson's pet grievance, the Standard Oil Company, cheaper* than he could before there was any such terrible "octopus," and when every producer had his favorite jobber; and if Mr. Hudson ever sent a telegram from New York to Chicago before the days of the Western Union Telegraph Company (which, naughty as it is, only charges twenty-five cents for ten words to Chicago), at the rate of about two dollars per ten words to Chicago, without grumbling at the positive incongruity of the price, he is a much more reasonable man than some of his readers take him to be. And to demonstrate that—whatever the immediate causes—the immediate effect of combinations is apt to be to convenience rather than to incommode the customer or client; let me allude, in passing, to (what everybody knows) the fact that the single

* The Standard Oil Company has so reduced the cost of the process of refining that the price of refined oil has been lowered from seventy to less than seven cents per gallon. The people who paid four dollars per capita for light now pay less than forty cents per capita, which is equivalent to a benefit to the people of this country (counting them at 60,000,000) of $216,000,000 per annum.—"New York Tribune," May 15, 1887.

powerful ownership of the telegraph lines of the United States has resulted in the steady improvement of the service (the sending of four messages at once upon a single wire and in opposite directions being not the greatest of these improvements). Perhaps Mr. Hudson thinks that these improvements would have been more patriotically used if the inventors had employed them to break down, instead of to aggrandize and strengthen, the "monopoly." But unless Mr. Hudson dreams of a paradise where inventors seek not to be paid, are not stimulated to activity by hope of reward (if, that is, he writes for his contemporaries and not for an ideal republic), he must be aware of the impossibility of legislating away the inducements to human industry or the instinct of men to prefer worldly prosperity and bank accounts to poverty and dependence. Had these inventions been used to break down existing companies, the result would have been finally the same. They would have been purchased by the strongest purse. But the inventor would first have been ruined. But Mr. Hudson, for one, still writes. Such propositions as that there is not a dollar of capital in the United States which does not represent somebody's labor and somebody's self-denial, or that every dollar which accrues in profit to-day to the railroads or other great corporate interests of this country represents from two hundred to three hundred dollars paid directly, and in cash, to the wage-workers (the very men for whom Mr. Hudson assumes to speak)—such propositions, I say, do not deter him in the least, nor do I anticipate that they ever will. If the corporations of the United States (chartered by the people of the United States for transportation, manufacturing, and other purposes), in endeavoring to keep abreast of the commerce and trade of the people of the United States, have grown to such enormous proportions as to attract the envy and enmity of those not holding their securities, I respectfully submit that that is no reason why those corporations should be punished, or their interests wrecked, embarrassed, or confiscated, Mr. Hudson to the contrary notwithstanding.

The fact—the truth is, that (however it may be in other countries) the accumulation of wealth and centralization of commerce in great combinations has never, in the United States, been a source of oppression or of poverty to the non-capitalist or wage-worker. The greatest oppressors of the poor, to the contrary, are not always the largest corporations. It is quite as likely, for example, to be a small Chatham Street haberdasher (who himself struggles against the bottom prices of his next-door "puller-in"), as a Broadway furnishing company, who pays a starved seamstress three cents apiece for making shirts, and holds a chattel mortgage on her sewing-machine as security

for the material upon which she operates it. Mr. Hudson appears to infer that the smaller the manufacturer, the better off the consumer and the wage-worker; that the smaller he is, the smaller his prices to the one and the higher his wages to the other. I do not claim that the larger the shirt-dealer, the higher the prices he pays to his seamstresses. I do not claim that the soulless individual becomes soulful the moment he finds himself incorporated (the epigram is the other way). But I do claim that the converse is not the fact. I have not had Mr. Hudson's opportunities, perhaps; but, so far as the laws of human selfishness and greed go, I happen to know that the larger the principal the more secure the wages of the wage-worker, and the scale thereof at least not necessarily or even probably lower.

The fact is (whether Mr. Hudson will ever become aware of it is another and less important consideration), that the very first thing a successful manufacturing combination does, and must do, is to put the price of its product down to a figure where it will not pay for designing speculators to form new stock companies for it to "crush" at a hundred or more cents on a dollar. For, did it keep up its prices, either one of two things would inevitably happen: either new factories would be started, or the inventive genius of this people would invent a substitute for the product they furnished, and so ruin the combination beyond resurrection.

So rapidly have prices lowered, indeed, in the past, and so constantly are they still falling, that earnest economists have begun to wonder what the end would be; and even the labor agitators have turned from the (to them) seemingly abstract question of hours and wages, as between the employer and the employed, to find in this the supposed greatest peril of the latter. It even appears that one Powderly, a chief of one of the so-called "labor movements," has made it the text of certain of his harangues. And, with what Dickens would call perhaps "a fatal freshness," Mr. Hudson himself (who has just left denying the right of industries to centralize themselves because the first thing they did after centralization was to put up prices), on the next page, says, "Mr. Powderly has inveighed against the sin of cheapness, and given his assent to the principle of combination to raise prices, on the assumption that such combinations involve an advance in wages." (Though to what purpose Mr. Hudson has preserved this excerpt his context fails to discover, since good faith to his own argument, if not to his readers, should have led to its suppression.)

But Mr. Hudson rattles on as follows: "It is an old truth that commerce, founded on the basis of distributing the staples of life at the least cost, is the highest practical benevolence;

while devices to rule commerce by the suspension of competition, and to exact arbitrary profits from the masses, are the extreme of selfishness and oppression. The universal nature of this truth was perceived when the world emerged from the mediæval system of economics, but it seems in danger of being forgotten. This is illustrated by the criticism of Mr. E. P. Alexander, the most recent writer on the railway question, that those who hold competition to be the only just measure of profits in any industry are years behind the age in comprehension of the science of the railway question."

Whatever there may be beyond platitude in the above is pure invention. The element of "the least cost" as parcel of the definition of "commerce" is certainly novel, and as interesting as it is novel. And certainly, too, the remainder of the sentence—from the words "the universal nature of this truth" (which truth ?—Mr. Hudson has alluded to several) onward—is an extremely remarkable statement to come from the pen of a writer who assumes to deal with economical questions and matters of social science. The allusion to Mr. Alexander is equally childish, and without bearing upon the matter which we believe Mr. Hudson claims to be discussing; unless, indeed, he thought it necessary to show, in passing, how thoroughly he had failed to comprehend the question of American railway systems, to the discussion of which Mr. Alexander has lately contributed a most admirable monograph. When Mr. Alexander used the words dragged from their context as above, he was pointing out how the question of modern industrial competition had long since ceased to involve simple problems of competition in getting business alone; how it at present includes also the element of the cost *versus* the price of doing business at all—that is to say, the value of the opportunity to do business at all, as against the actual outlay in cost necessary to do the business brought to the party offering to do the business at all (which element, everybody—who knows anything of the matter at all—knows to be not only a very serious and a very practical one, but actually the paramount one, under present conditions). (As others besides Mr. Hudson may be ignorant of Mr. Alexander's meaning just here, I may explain that, to the railway, the value of doing a competing business, of keeping its trains running and so perpetuating its charter, is naturally always a larger consideration than the mere question of a profit—is, in fact, the most vital consideration that could be named. Or, should the question present itself differently: a bankrupt railroad is worse than no railroad at all. It can run recklessly and cheaply, since unable to respond in damages for lives or property injured or destroyed. And yet, were competition the only rule by which

railways were operated among themselves, this very bankrupt road could force every neighboring road to regulate itself by its own tortuous procedure. For, just as a chain is no stronger than its weakest link, so the best railroad in the country can be no better than the worst, if competition and nothing but competition is to be the rule.)

But with all earthly matters Mr. Hudson will have nothing but competition. He will not hear of such a thing as a combination. He proceeds: "But the very question at issue is whether they (i. e., these old ideas of competition) are not more in accord with the essential principles of nineteenth-century democracy than those who are turning commerce back to the era of prices fixed by combinations and the suspension of competition." If this is the very question at issue, it would seem as if Mr. Hudson has so far been artfully misleading us. He certainly has not alluded to it before. So far as careful perusal of his paper has informed us, the question at issue seemed to be whether a small manufacturer had a right to sell out his business to a bigger one; at what point a large manufacturer, who has used his capital in buying out his smaller neighbors, must call a halt, and submit to a redistribution all around; and as to whether small manufacturers should be compelled to do business at a loss rather than sell out to larger ones. However, let us patiently shift our ground as often as necessary, if so be we can discover what it is that our Mr. Hudson really does mean. If it is a fact that modern civilization has really introduced new elements—and other principles besides the principle of competition—into commerce, then by all means let us abolish, let us destroy them (Mr. Hudson knows how to destroy a principle), and get back at once—to what? Not to feudal days, certainly; for that would be modern feudalism, and that is what Mr. Hudson will none of. Perhaps we had better, while we are about it, go back to the Deluge, to Noah the navigator, who spent one hundred and twenty years in building a ship whose quarter-deck he was himself to tread—although it does not appear that Noah had any competitors in the ark-building trade—to the patriarchal rather than to the feudal system.

But, having decided where to go, how are we to turn back commerce? What is commerce? Webster says that what we mean by that term is "the interchange or mutual change of goods, wares, productions, or property of any kind between nations, by purchase and sale, trade, traffic." Very powerful indeed, one would imagine, must be the forces or agencies which shall turn back such tendencies as these—the operations of the laws of human necessity which culminate in the rule of supply and demand as working upon the entire human race. Accord-

ing to Mr. Hudson, however, these tendencies, laws, and rules do not amount to so very much. It is an easy enough matter to handle them. We have only to legislate railway companies out of existence, and then enact statutes forbidding two of the same trade to combine. Then things will run smoothly. The State will hold the trackage of the late railroad companies as a highway; and every dealer, manufacturer, agriculturist, miner, will carry his product to and fro, and—there you are! No more modern feudalism; nothing but peace, plenty, and communism!

Faulconridge would not fright boys with bugs, but a moral drawn from the middle ages, by reason of its mere remoteness, appears always to be a powerful antic with which to worry the non-capitalist imagination. Any combination of like interests for business purposes—the copartnership formed by three butter-dealers or six coal-miners to continue the business of selling butter or mining coal; the corporation, or "trust," or combination formed by amalgamation of any existing companies—is a palpable return to the days of feudalism. Thus, the present system of combinations becomes "modern feudalism." Your combinations are so large that they build up a favored and aristocratic class, like the old crown vassals. And again, these industrial combinations are hand and glove with the railways, and so form a network of capital in the meshes of which the poor man is strangled. Now, the simple facts upon which Mr. Hudson assumes to found this hue and cry are these, viz.: The normal tendency of trade to trade-centers, where it can be most conveniently handled, has its inevitable corollary in the tendency, within the trade-center, to centralization of the different branches of trade. In the middle ages the principle operated to build up such imperial centers as Nuremberg, Antwerp, and London, and the corollary to organize, within those centers, the great trade-guilds. In later years the Atlantic Ocean, the Hudson River, and Long Island Sound combined to make New York city an emporium for the deposit and distribution of the products and industries of two continents, while the merely innocent convenience of traders within that city (not any aristocratic or would-be feudal motives on their part) operated to root and group the leather interest into one quarter, cotton goods into another, oils and provisions and iron-mongery into still others. And if two or more traders in an identical staple, finding themselves neighbors or united in a community of interest, saw fit to bind themselves into a single firm or trading company, it was no matter of conspiracy against the public weal, but the merest consideration of personal convenience and facility. When the railroads came, they found themselves obliged—by the very charters which created them—to haul for anybody who chose to em-

ploy them, and to do the most extensive hauling for those who had the largest bulk of hauling for them to do. They were not authorized by their acts of incorporation to first demand certificates of good moral character, or affidavits that the would-be customer was not a combination of individuals or stockholders in a trust or a private corporation. And yet, superfluous as this statement is, it is actually out of such familiar truisms as these (it is difficult to treat the simpleness of the situation without tautology) that Mr. Hudson raises figment after figment and chimera after chimera to disturb and alarm the non-producing and manufacturing classes of this already imperiled community! And the purport of these figments and the portent of these chimeras is always that any use of capital in bulk is crime against this people and this republic; and that the incorporation for business purposes "stands in" with some railway company or all railway companies, because incorporations—and especially railway incorporations—hate the bread-winner and the wage-worker, and desire that he be crushed and swept from the face of the earth; in other words, are feudal, mediæval, and unpatriotic. That is the whole text and comment of Mr. Hudson's elocution. Even feudalism itself was not a curse. It was a proper and convenient institution for its day and date; considering the popular ignorance and helplessness, anything else would have been a less tolerable tyranny. It was the growth of circumstances, rather than—as Mr. Hudson thinks—the forcing of an arbitrary situation by the strong and aristocratic upon the plebeian and the weak: so, to begin with, granting Mr. Hudson's favored and capitalist class, and granting that they "force" any condition of things upon the non-capitalist class, the analogy of this state of things to the institution of feudalism is false and misleading. But feudalism was more than a situation. It was the only form in which the society of the unlettered and formative civilization could be held together at all—the only one which could, on the one hand, curb the despotism of thrones, while on the other conserving the safety and tranquillity of the people. It was the mother of parliamentary government and of civil liberty, to which—in the fullness of time—it yielded and disappeared.

To give a meaning to Mr. Hudson's vision of an analogy between modern industrial centralization and feudalism, let us assume, however, that he means (he does not say so) the mediæval trade-guilds. Now, these trade-guilds, perhaps, were an accompaniment of—certainly they were contemporary with—the institution of feudalism. Moreover, they were broken up and wiped away by the very institution which Mr. Hudson can not find words enough to stigmatize as the root of every modern

evil—viz., the growth of private capital and the combinations of capitalists. The mediæval guild was a thing apart, and its type and character have disappeared forever; and yet, peaceful and judicious as those guilds were, even the anarchist and labor unionist of to-day may dignify his district delegation by comparing it to the guilds of the middle ages, with more show of reason than can Mr. Hudson compare them to our modern corporations. The modern trades-union is an organization whose object is to monopolize—or at least to secure—the right to labor for wages for its own members; to prevent by force, if necessary and convenient (and it latterly has been supposed to be both necessary and convenient), the labor of anybody not one of its members; and to boycott any employer who claims the right to employ the labor of anybody and everybody not its members. The ancient guild was composed of the masters of a certain trade; of men who had, by mastering its practical art, become entitled to that designation—men who practiced it for a livelihood. It had also the industrial and educational function of perpetuating itself by the training of its apprentices to become, in their turn, masters. In the days of feudalism, when the great crown tenants held their territory from the crown by fee of service in its wars (a service they levied on the people to perform in time of war, grinding a profit to themselves by way of reprisal from this same people in time of peace), these guilds preserved the useful arts which ameliorate our own happier times. Each guild met and discussed the state of its particular trade; devised means of improving it (their discussions taking the place now filled by the industrial newspaper, the trade-journal, and the price-current). It passed laws also; but these laws were for the guidance of its own members, not by any means to be supplied outside of it in an attempt by force of arms to make employment for its own members at the expense of the vested rights and liberties of the rest of mankind. So honorable were they in thought, deed, and word, that the wealthiest London merchant to-day is not above marching in procession in their memory behind their banners on Lord-Mayor's-day, arrayed, as Chaucer says they were in his:

> ". . . in one livery
> Of a great and solemn Fraternitie."

To compare them to the unhappy organizations of which laboring-men to-day are the coerced victims—wherein the ignorance of the honest wage-worker is used to deplete his small earnings for the support of vile "master-workmen" and "walking delegates" who toil not, neither spin—and the artificer in brass or iron of mediæval times (who kept his apprentices in his own household as a part of his family, to succeed him as a mas-

ter of his trade and as a member of his guild) with the modern "knight of labor," who will not that any should toil for bread who has not first paid a tax to his "lodge" or "headquarters" or camp—is to insult the guild of the middle ages and its master. But, for all that, the guild and the trades-union are nearer in theory and in practice than the guild and the modern business corporation as chartered in any known quarter of the civilized world to-day. One thing, however, there was in those middle ages, of which, happily for Mr. Hudson and his kind, no analogy has survived—namely, statutes against heresy and seditious utterances, and capital punishments, such as disemboweling, the axe, fagot, etc., for the stirrer-up of discord and unreasonable public discontent. So much for feudalism and the guilds.

Mr. Hudson's next sentence is a long one, and it reads heroically: "It is the almost universal plea, in mitigation for this infraction of economic law, that the capital engaged in combination can not earn fair profits if competition is allowed free play. But what constitutes the just measure of reward for capital? What are the fair profits for capital seeking investment in bonds, mortgages, or loans on commercial paper? The rate of interest that is fixed by free competition. What is the just measure of returns on capital invested in houses, stores, farms, small manufactures, or a thousand other forms of ordinary enterprise? Free competition. What, indeed, is the force which fixes the rate of wages, despite efforts of labor organizations to oppose combination to the action of that force, and notwithstanding the violence provoked where these organizations are brought into conflict with the great combinations of capital? The competition of labor for wages. But the result of combination is to establish, for a favored class of capital, by means of the control of the highways of commerce, an exemption from the force which fixes the just reward of all other human effort, so that excessive profits can be exacted from the masses, to be counted by the tens of millions annually; and if the ideal of railway pooling could be attained, this policy would impose upon the nation a burden of fictitious capital three times the amount of the national debt!"

The term "free competition" in the above, as we have shown, means "forced competition" (at least it means that if the remainder of Mr. Hudson's paper means anything). A and B must compete, whether they will or no: the moment they combine and become A & B, or A, B & Co., or The A and B Manufacturing Company, they are a public calamity and a standing threat to our free institutions! The reader will notice also that labor organizations are law-abiding, peaceful, and highly creditable organizations, unless unhappily "brought into conflict with the

great combinations of capital," in which case, of course, the broken heads and boycotts are the fault of the great combinations. (Query: What "great combination of capital" was at fault in the case of the poor widow whose bakery business was broken up in this city recently because she kept a journeyman baker who did not happen to be a member of a particular boycotters' union which was "competing for labor" in the vicinity of her bake-shop ?) A few other simple negations are necessary in disposing of the above sentence—namely: There is no such thing as "the rate of interest" that is "fixed by free competition." The rates of interest are fixed by the laws of demand and supply in the mercantile world, and by statute so far as courts and legal proceedings are concerned. Labor does not, even when wicked capital combines, compete for wages. It appears to be oftener the rule, nowadays, that wages compete for labor; and finally, the combination or centralizing of capital is not an infraction of economic law at all; nor are any one of the above statements we have been at the pains to contradict ever offered as a "plea" or as "pleas" for such an infraction. As to what the "competition of labor for wages" is at the present date, we may illustrate by a single example. Last summer the workmen in a sugar-refinery in Brooklyn struck for an advance in wages. The proprietor called them together, showed them his books, explained to them his expenses, and demonstrated to them that if he paid them the wages demanded, his sugar would cost him more than the market price at which imported sugars were that moment selling in New York city, and that, therefore, he not only could not compete with the imported sugar, but must close his refinery. The "walking delegate," however, had his orders: the strike could not be "off." The rates must be paid; and so the refinery was closed. But, in this Mr. Hudson perceives nothing but justice. Having declined to see that the laws of supply and demand have anything to do with prices, why should they stand in the way of a capitalist paying what wages his "competing workmen" demand? The owner of the Brooklyn refinery was one of the "favored class of capital," who, "by means of the control of the highways of commerce" (the refinery in question stands on the dock, and ocean-going vessels load and discharge at its hatches), "establish an exemption from the force which fixes the reward of human effort." But in this case some force (whether that of the "walking delegate" or of the laws of commerce, or of the New York market) closed his refinery, nevertheless. The workmen who refused to keep their contracts of employment with the sugar-refiner—nay (for such the facts were), threatened to break his machinery and burn and pillage his establishment—and who, by force and arms, kept

other workmen from taking their places, were in reality honest, well-meaning, law-abiding citizens! But they had unhappily been "brought into conflict with great combinations of capital," and Mr. Hudson's arguments are not answerable for the result. You and I have a perfect right to use our means to manufacture sugar or to mine for coal, or to add to the prosperity and wealth of our community by adding to our own by employing it in any industry we may elect for. But we must be careful not to stand in the highway where "the competition of labor for wages" may be perchance brought into our vicinity. For that competition might happen to run up against us, and so be brought into conflict with us, and thereby "violence" might be "provoked." And then, if our business is ruined and our property destroyed, Mr. Hudson is not responsible—we had fair warning! Mr. Hudson can fill his pages with any doctrines it pleases him to invent, and find publishers for them; but he will not pay us for our smoking factories and broken machinery. That is our affair, not Mr. Hudson's.

Mr. Huxley somewhere speaks of gentlemen who put their statements "into italics as the queen puts her soldiers into bear-skin caps, to make them look formidable." Mr. Hudson puts his statements into figures for the same paramount purpose. His picture of the bloated capitalists, by combinations extracting from the masses a sum three times as large as the national debt, is appalling, to be sure. And were this not sufficiently appalling, he adds to it the following dazzling array: "Let us suppose, for the sake of the argument, that the abolition of competition will return a certain proportion of the enhanced profits to the workingman in the shape of increased wages. If the anthracite-coal pool raises the price of coal fifty cents per ton, and gives the miners ten cents of the advance, a gain of $3,000,000 is secured in the annual wages of the miners; but a burden of $15,000,000 is imposed on the labor that consumes the coal. If the coke syndicate raises its price fifty cents per ton, and gives its workingman ten cents advance, the advantage to labor at the coke-ovens is $400,000 in a year; but a loss of many times the amount is inflicted on labor in the various forms in which that product finally reaches the consumer. If the same operation were repeated by combinations controlling every industry and every staple of consumption, what would be the result? An addition would be made to the cost of life, of which one fifth would be given back to labor in the form of increased wages, and four fifths would be drawn from labor to swell the profits of capital. Change the proportion to whatever form you like, the fact remains that all these combinations are organized to increase the profits of the capital

engaged in them; and the increase must either be drawn from the pockets of consumers or extracted from the wages of laborers."—(Page 286.)

Monstrous! The idea of a combination being organized to increase its profits! What an example to the youth of America! What utter demoralization would ensue did it become the habit of our citizens generally to go into trade to increase their profits! Let every statesman, every economist, every preacher in the land, impress upon this generation rather the duty of every man to go into trade for the good of somebody else, and to continue therein to lessen, not to increase, his worldly store! Let him run his business, his warehouse, his factory, his steamships and railroads at a loss, and, the moment he finds his transactions profitable, let him wind up, lest he should "swell the profit of capital"; and if he will not, let the law, or Mr. Hudson, see to it.

So long as the tendency of the products of the earth is to find a market, just so long will it be the tendency within that market for the handling of different classes of products to centralize, until corn and grain are handled in one locality, pork and packed provisions in another, fruits in another, hides and pelts and leather in another. Here is natural law, and here is Mr. Hudson, too, demonstrating the imminent danger to the United States from the normal operation of this natural law. There is, of course, but one remedy for all this (though Mr. Hudson, indeed, fails to point it out), namely, a strong centralized, paternal government like that of the late Brigham Young, who walked in and out among his people, encouraging them in their efforts to amass fortunes; and then, when the fortunes were amassed, receiving heavenly visions instructing the "sealing" of those fortunes to himself! Such a governmental paternity, to be sure, might answer Mr. Hudson's purposes in confiscating the accretions of private capital. But it is difficult to see how otherwise than under just such a particular state we could enjoy the reforms he seeks.

Whenever it shall appear, or come to pass, that the interests of consumers (that is, of the people) are imperiled by the methods which the ramifications of modern civilization impose upon commerce and the operations of trade, it may come within the constitutional jurisdiction of Congress to inquire into and abridge those methods. But until such time shall come is it not, or ought it not to be, a question whether gentlemen who assume to deal with economic questions do not owe some duty to their country—not the old Greek idea of patriotism, perhaps, but still a duty—and whether that duty might not properly consist in declining to supply specious and sophistical propositions to become fire-brands in the grasp of poverty and of ignorance?

A GREAT CONFESSION.

By THE DUKE OF ARGYLL.

AMONG the many distinguished men who have contributed to the world's plebiscite in favor of the Darwinian hypothesis on the origin of species, there is no one name more distinguished than that of Mr. Herbert Spencer. He has pursued the idea of development with wonderful ingenuity through not a few of its thousand ramifications. He has carried it into philosophy and metaphysics. He has clothed it in numerous and subtle forms of speech, appealing to various faculties, and offering to each its appropriate objects of recognition. He is the author of that other phrase, "the survival of the fittest," which has almost superseded Darwin's own original phrase of "natural selection." Nothing could be happier than this invention for the purpose of giving vogue to whatever it might be supposed to mean. There is a roundness, neatness, and compactness about it, which imparts to it all the qualities of a projectile with immense penetrating power. It is a signal illustration of itself. It is the fittest of all phrases to survive. There is a sense of self-evident truth about it which fills us with satisfaction. It may perhaps be suspected sometimes of being a perfect specimen of the knowledge that puffeth up, because there is a suggestion about it—not easily dismissed—that it is tautological. The survival of the fittest may be translated into the survival of that which does actually survive. But the special power of it lies in this, that it sounds as if it expressed a true physical cause. It gets rid of that detestable reference to the analogies of mind which are inseparably associated with the phrase of natural selection. It is the great object of all true science—as some think—to eliminate these, and if possible to abolish them. Survival of the fittest seems to tell us not only of that which is, but of that which must be. It breathes the very air of necessity and of demonstration. Among the influences which have tended to popularize the Darwinian hypothesis, and to give it the imposing air of a complete and satisfactory explanation of all phenomena, it may well be doubted whether anything has been more powerful than the universal currency of this simple formula of expression.

Such is the authority who has lately contributed to this Review two papers upon "The Factors in Organic Evolution." The very title is significant. The survival of the fittest is a cause which after all does not stand alone. It is not so complete as it has been assumed to be. There are in organic evolution

more elements than one. There is concerned in it not one cause but a plurality of causes. A "factor" is specially a doer. It is that which works and does. It is a word appropriated to the conception of an immediate, an efficient cause. And of these causes there are more than one. Neither natural selection nor survival of the fittest is of itself a sufficient explanation. They must be supplemented. There are other factors which must be admitted and confessed.

This is the first and most notable feature of Mr. Spencer's articles. But there is another closely connected with it, and that is the emphatic testimony he bears to the fact that the existing popular conception is unconscious of any defect or failing in the all-sufficiency of the Darwinian hypothesis. He speaks of the process brought into clear view by Mr. Darwin, and of those with whom he is about to argue, as men "who conclude that taken alone it accounts for organic evolution."* In order to make his own coming contention clearer, he devises new forms of expression for defini g acurately the hypothesis of Darwin. He calls it "the natural selection of favorable variations." Again and again he emphasizes the fact that these variations, according to the theory, were "spontaneous," and that their utility was only "fortunate," or, in other words, accidental. He speaks of them as "fortuitously arising";† and it is of this theory, so defined and rendered precise, that he admits that it is now commonly supposed to have been "the sole factor" in the origin of species.

It is surely worth considering for a moment the wonderful state of mind which this declaration discloses. When Mr. Herbert Spencer here speaks of the "popular" belief, he is not speaking of the mob. He is not referring to any mere superstition of the illiterate multitude. He is speaking of all ranks in the world of science. He is speaking of some overwhelming majority of those who are investigators of Nature in some one or other of her departments, and who are supposed generally to recognize as a cardinal principle in science, that the reign of law is universal there—that nothing is fortuitous—that nothing is the result of accident. Yet Mr. Herbert Spencer represents this great mass and variety of men as believing in the preservation of accidental variations as "the sole factor," and as the one adequate explanation in all the wonders of organic life.

Nor can there be any better proof of the strength of his impression upon this subject than to observe his own tone when he ventures to dissent. He speaks, if not literally with bated breath, yet at least with a deferential reverence for the popular

* Page 570. ("Popular Science Monthly," vol. xxviii, p. 759.)

† Page 575. ("Popular Science Monthly," vol. xxviii, p. 765.)

dogma, which is really a curious phenomenon in the history of thought. "We may fitly ask," he says, whether it "accounts for" organic evolution. "On critically examining the evidence," he proceeds, "we shall find reason to think that it by no means explains all that has to be explained." And then follows an allusion of curious significanco. "Omitting," says Mr. Spencer, "for the present any consideration of a factor which may be distinguished as primordial—"* Here we have the mind of this distinguished philosopher confessing to itself—as it were in a whisper and aside—that Darwin's ultimate conception of some primordial "breathing of the breath of life" is a conception which can only be omitted "for the present." Meanwhile he goes on with a special, and it must be confessed a most modest, suggestion of one other "factor" in addition to natural selection, which he thinks will remove many difficulties that remain unsolved when natural selection is taken by itself. But while great interest attaches to the fact that Mr. Herbert Spencer does not hold natural selection to be the sole factor in organic evolution, it is more than doubtful whether any value attaches to the new factor with which he desires to supplement it. It seems unaccountable indeed that Mr. Herbert Spencer should make so great a fuss about so small a matter as the effect of use and disuse of particular organs as a separate and a newly recognized factor in the development of varieties. That persistent disuse of any organ will occasion atrophy of the parts concerned, is surely one of the best established of physiological facts. That organs thus enfeebled are transmitted by inheritance to offspring in a like condition of functional and structural decline, is a correlated physiological doctrine not generally disputed. The converse case—of increased strength and development arising out of the habitual and healthy use of special organs, and of the transmission of these to offspring—is a case illustrated by many examples in the breeding of domestic animals. I do not know to what else we can attribute the long, slender legs and bodies of greyhounds so manifestly adapted to speed of foot, or the delicate powers of smell in pointers and setters, or a dozen cases of modified structure effected by artificial selection.

But the most remarkable feature in the elaborate argument of Mr. Spencer on this subject is its complete irrelevancy. Natural selection is an elastic formula under which this new "factor" may be easily comprehended. In truth, the whole argument raised in favor of structural modification arising out of functural use and disuse, is an argument which implies that Mr. Spencer has not himself entirely shaken off that interpretation of natural selection which he is disputing. He treats it as

* Page 570. ("Popular Science Monthly," vol. xxviii, p. 759.)

if it were the definite expression of some true physical and efficient cause, to which he only claims to add some subsidiary help from another physical cause which is wholly separate. But if natural selection is a mere phrase, vague enough and wide enough to cover any number of the physical causes concerned in ordinary generation, then the whole of Mr. Spencer's laborious argument in favor of his "other factor" becomes an argument worse than superfluous. It is wholly fallacious in assuming that this "factor" and "natural selection" are at all exclusive of, or even separate from, each other. The factor thus assumed to be new is simply one of the subordinate cases of heredity. But heredity is the central idea of natural selection. Therefore natural selection includes and covers all the causes which can possibly operate through inheritance. There is thus no difficulty whatever in referring it to the same one factor whose solitary dominion Mr. Spencer has plucked up courage to dispute. He will never succeed in shaking its dictatorship by such a small rebellion. His little contention is like some bit of Bumbledom setting up for Home Rule—some parochial vestry claiming independence of a universal empire. It pretends to set up for itself in some fragment of an idea. But here is not even a fragment to boast of or to stand up for. His new factor in organic evolution has neither independence nor novelty. Mr. Spencer is able to quote himself as having mentioned it in his "Principles of Biology" published some twenty years ago; and by a careful ransacking of Darwin he shows that the idea was familiar to and admitted by him at least in his last edition of the "Origin of Species." Mr. Spencer insists that this fact is evidence of a "reaction" in Darwin's mind against the sole factorship of natural selection. Darwin was a man so much wiser than all his followers, and there are in his book so many indications of his sense of our great ignorance, that most probably he did grow in the consciousness of the necessary incompleteness and shortcomings of his own explanations. But there was nothing whatever to startle him in the idea of heredity propagating structural change, through functional use and disuse. This idea was not incongruous with his own more general conception. On the contrary, it was strictly congruous and harmoniously subordinate. He did not profess to account for all the varieties which emerge in organic forms. Provisionally, and merely for the convenience of leaving that subject open, he spoke of them as fortuitous. But to assume the really fortuitous or accidental character of variation to be an essential part of this theory, is merely one of the many follies and fanaticisms of his followers.

Although, therefore, the particular case chosen by Mr. Herbert Spencer to illustrate the incompetency of natural selection,

taken alone, to explain all the facts of organic evolution, is a case of little or no value for the purpose, yet the attitude of mind into which he is thrown in the conduct of his argument leads him to results which are eminently instructive. The impulse "critically to examine" such a phrase as "natural selection" is in itself an impulse quite certain to be fruitful. The very origin of that impulse gives it of necessity right direction. Antagonism to a prevalent dogma so unreasoning as to set up such a mere phrase as the embodiment of a complete philosophy, is an antagonism thoroughly wholesome. Once implanted in Mr. Herbert Spencer's mind, it is curious to observe how admirably it illustrates the idea of development. Having first sought some shelter of authority under words of the great prophet himself, he becomes more and more aggressive against the pretenders to his authority. His grumbles against them become loud and louder as he proceeds. He speaks of "those who have committed themselves to the current exclusive interpretation." * He observes upon "inattention and reluctant attention" as leading to the ignoring of facts. He speaks of "alienation from a belief" as "causing naturalists to slight the evidence which supports that belief, and refuse to occupy themselves in seeking further evidence." He compares their blindness now respecting the insufficiency of natural selection with the blindness of naturalists to the facts of evolution before Darwin's book appeared. He marshals and reiterates the obvious considerations which prove that the development of animal forms must necessarily depend on an immense number and variety of adjusted changes in many different organs, all co-operating with each other, and all nicely adjusted to the improved functional actions in which they must all partake. He reduces the practical impossibility of such changes occurring as the result of accident to a numerical computation. He tells his opponents that the chances against any adequate readjustments fortuitously arising "must be infinity to one." † But more than this: he not only repels the Darwinian factor as adequate by itself, but, advancing in his conclusions, he declares that it must be eliminated altogether. On further consideration he tells us that in his opinion it can have neither part nor lot in this matter. He insists that the correlated changes are so numerous and so remote that the greater part of them can not be ascribed (even) in any degree to the mere selection of favorable variations. ‡ Then facing the opponents whose mingled credulities and incredulities he has so offended, he rebukes their fanaticisms according to a well-known

* Page 581. ("Popular Science Monthly," vol. xxviii, p. 770.)
† Page 571. ("Popular Science Monthly," vol. xxviii, p. 765.)
‡ Page 574. ("Popular Science Monthly," vol. xxviii, p. 761.)

formula: "Nowadays," he says, "most naturalists are more Darwinian than Mr. Darwin himself." * This is most true; and Mr. Herbert Spencer need not be the least surprised. All this happens according to a law. When a great man dies, leaving behind him some new idea—new either in itself or in the use he makes of it—it is almost invariably seized upon and ridden to the death by the shouting multitudes who think they follow him. Mr. Herbert Spencer here directs upon their confusions the searching light of his analysis. He most truly distinguishes Darwin's hypothesis in itself, first from the theory of "organic evolution in general," and secondly from "the theory of evolution at large." This analysis roughly corresponds with the distinctions I have pointed out in the preceding paper; and when he points to the confounding of these distinctions under one phrase as the secret of wide delusions, he has got hold of a clew by which much further unraveling may be done. Guided by this clew, and in the light of this analysis, he brings down Darwin's theory to a place and a rank in science which must be still further offensive to those whom he designates as the "mass of readers." He speaks of it as "a great contribution to the theory of organic evolution." It is in his view a "contribution," and nothing more—a step in the investigation of a subject of enormous complexity and extent, but by no means a complete or satisfactory solution of even the most obvious difficulties presented by what we know of the structure and the history of organic forms.

It is no part of my object in this paper to criticise in detail the value of that special conception with which Mr. Herbert Spencer now supplements the deficiencies of the Darwinian theory. He calls it "inheritance of functionally produced modifications," and he makes a tremendous claim on its behalf. He evidently thinks that it supplies not only a new and wholly separate factor, but that it goes a long way toward solving many of the difficulties of organic evolution. Nothing could indicate more strongly the immense proportions which this idea has assumed in his mind than the question which he propounds toward the conclusion of his paper. Supposing the new factor to be admitted, "do there remain," he asks, "no classes of organic phenomena unaccounted for?" Wonderful question, indeed! But at least it is satisfactory to find that his reply is more rational than his inquiry: "To this question, I think it must be replied that there do remain classes of organic phenomena unaccounted for. It may, I believe, be shown that certain cardinal traits of animals and plants at large are still unexplained"; and so he proceeds to the second paper, in which the still refractory residuum is to be reduced.

* Page 584. ("Popular Science Monthly," vol. xxviii, p. 773.)

Whatever other value may attach to an attempt so ambitious, it is at least attended with this advantage, that it leads Mr. Herbert Spencer to follow up the path of "further consideration" into the phrases and formulæ of the Darwinian hypothesis. And he does so with memorable results. What he himself always aims at is to obliterate the separating lines between the organic and the inorganic, and to reduce all the phenomena of life to the terms of such purely physical agencies as the mechanical forces, or as light, heat, and chemical affinity, etc. In this quest he finds the Darwinian phrases in his way. Accordingly, although himself the author and inventor of the most popular among them, he turns upon them a fire of most destructive criticism. He allows them to be, or to have been, "convenient and indeed needful" * in the conduct of discussion, but he condemns them as "liable to mislead us by veiling the actual agencies" in organic evolution. That very objection which has always been made against all phrases involving the idea of creation—that they are metaphorical—is now unsparingly applied to Darwin's own phrase "natural selection." Its "implications" are pronounced to be "misleading." The analogies it points at are indeed definite enough, but unfortunately the "definiteness is of a wrong kind." "The tacitly implied 'nature' which selects, is not an embodied agency analogous to the man who selects artificially." This cuts down to the very root of the famous formula, and to that very element in it which has most widely commended it to popular recognition and acceptance. But this is not all. Mr. Herbert Spencer goes, if possible, still deeper down, and digs up the last vestige of foundation for the vast but rambling edifice which has been erected on a phrase. The special boast of its worshipers has always been that it represented and embodied that great reform which removed the processes of organic evolution once and forever from the dominion of deceptive metaphor, and founded them for the first time on true physical causation. But now Mr. Herbert Spencer will have none of this. The whole of this pretension goes by the board. He pronounces upon it this emphatic condemnation: "The words natural selection do not express a cause in the physical sense." † It is a mere "convenient figure of speech." ‡

But even this is not enough to satisfy Mr. Spencer in his destructive criticism. He goes himself into the confessional. He had done what he could to amend Darwin's phrase. He had "sought to present the phenomena in literal terms rather than metaphorical terms," and in this search he was led to "survival

* Page 749. ("Popular Science Monthly," vol. xxix, p. 55.) † Ibid.

‡ Page 750. ("Popular Science Monthly," vol. xxix, p. 55.)

of the fittest." But he frankly admits that "kindred objections may be urged against the expression," to which this leading led him. The first of these words in a vague way, and the second word in a clear way, call up an idea which he must admit to be "anthropocentric." What an embarrassment it is that the human mind can not wholly turn the back upon itself! Self-evisceration, the happy dispatch of the Japanese, is not impossible or even difficult, although when it is done the man does not expect to continue in life. But self-evisceration by the intellectual faculties is a much more arduous operation, especially when we expect to go on thinking and defining as before. It is conceivable that a man might live at least for a time without his viscera, but it is not conceivable that a mind should reason with only some bit or fragment of the brain. In the mysterious convolutions of that mysterious substance there are, as it were, a thousand retinæ—each set to receive its own special impressions from the external world. They are all needed; but they are not all of equal dignity. Some catch the lesser and others catch the higher lights of nature; some reflect mere numerical order or mechanical arrangement, while others are occupied with the causes and the reasons and the purposes of these. Some philosophers make it their business to blindfold the facets which are sensitive to such higher things, and to open those only which are adapted to see the lower. And yet these very men generally admit that the faculties of vision which see the higher relations are peculiarly human. They are so identified with the human intellect that they can hardly be separated. And hence they are called anthropomorphic, or as Mr. Spencer prefers to call them "anthropocentric." This close association—this characteristic union—is the very thing which Mr. Spencer dislikes. Yet the earnest endeavors of Mr. Spencer to get out of himself—to eliminate every conception which is "anthropocentric"—have very naturally come to grief. "Survival"? Does not this word derive its meaning from our own conceptions of life and death? Away with it, then! What has a true philosopher to do with such conceptions? Why will they intrude their noxious presence into the purified ideas of a mind seeking to be freed from all anthropocentric contamination? And then that other word "fittest," does it not still more clearly belong to the rejected concepts? Does it not smell of the analogies derived from the mortified and discarded members of intelligence and of will? Does it not suggest such notions as a key fitting a lock, or a glove fitting a hand, and is it worthy of the glorified vision we may enjoy of Nature to think of her correlations as having any analogy with adjustments such as these? In the face of the innumerable and complicated adjust-

ments of a purely mechanical kind which are conspicuous in organic life, Mr. Spencer has the courage to declare that "no approach" to this kind of fitness "presentable to the senses" is to be found in organisms which continue to live in virtue of special conditions. Where materials are so abundant it is hard to specify. But I am tempted to ask whether Mr. Spencer has ever heard of the ears, the teeth, above all the finger of the aye-aye, the wonderful beast that lives in the forest of Madagascar, and is very nicely fitted indeed to prey upon certain larvæ which burrow up the pith of certain trees? Here we see examples of fitting in a sense as purely mechanical as he could possibly select from human mechanism. The enormous ears are fitted to hear the internal and smothered raspings of the grub. The teeth are fitted for the work of cutting-chisels, while one finger is reduced to the dimension of a mere probe, armed with a hooked claw to extract the larvæ. The fitting of this finger-probe into the pith-tube of the forest bough is precisely like the fitting of a finger into a glove. It is strange indeed that Mr. Spencer should deny the applicability of the word fitness, in its strictest "glove" sense, to adaptations such as these. Yet he does deny it in words emphatic and precise. Neither the organic structures themselves—he proceeds to say—nor their individual movements are related in any analogous way to the things and actions in the midst of which they live. Having made this marvelous denial, he reiterates in another form his great confession—his *gran rifiuto*—that his own famous phrase, although carefully designed to express self-acting and automatic physical operations, is, after all, a failure. And this result he admits not only as proved, but as obviously true. His confession is a humble one. "Evidently," he says, "the word fittest as thus used is a figure of speech." *

This elaborate dissection and condemnation by Mr. Herbert Spencer of both the two famous phrases which have been so long established in the world as expressing the Darwinian hypothesis —his emphatic rejection of the claim of either of them to represent true physical causation—his sentence upon both of them that they are mere figures of speech—is, in my judgment, a memorable event. As regards Mr. Spencer himself, it is a creditable performance and an honorable admission. It is one of the high prerogatives of the human mind to be able to turn upon its own arguments, and its own imaginings, the great weapon of analysis. There are in all of us, not only two voices, but many voices, and splendid work is done when the higher faculties call upon the lower to give an account of what they have said and argued. Often and often, as the result of such a call, we should

* Page 751. ("Popular Science Monthly," vol. xxix, p. 56.)

catch the accents of confession saying: "We have been shutting our eyes to the deepest truth, keeping them open only to others which were comparatively superficial. We have been trying to conceal this by the invention of misleading phrases—full of loose analogies, of vague and deceptive generalities."

Most unfortunately, however, the special peculiarity of Mr. Spencer's introspection appears to be that it is the lower intellectual faculties which are calling the higher to account. The merit of Darwin's phrase lay in its elasticity—in its large elements of metaphor taken from the phenomena of mind. Mr. Spencer's phrase had been carefully framed, he tells us, to get rid of these. His great endeavor was to employ in the interpretation of Nature only those faculties which see material things and the physical forces. Those other faculties which see the adjustments of these to purpose—to the building up of structures yet being imperfect, and to the discharge of functions yet lying in the future—it was his desire to exclude or silence. This was his aim, but he now sees that he has failed. In spite of him the higher intellectual perceptions have claimed admittance, and have actually entered. He now calls on the humbler faculties to challenge this intrusion, and to assert their exclusive right to occupy the field. The "survival of the fittest" had been constructed to be their fortress. But the very stones of which it is built—the very words by which the structure is composed—are themselves permeated with the insidious elements which they were intended to resist. The "survival of the fittest" is a mere redoubt open at the back, or a fort which can be entered at all points from an access underground. And so, like a skillful general, Mr. Spencer has ordered a complete evacuation of the works.

But in giving up this famous phrase Mr. Spencer does not give up his purpose—which, indeed, is one of the main purposes of his philosophy—namely, to build up sentences and wordy structures which shall eliminate, as far as it is possible to do so, all those aspects of natural phenomena which are human, that is to say, those aspects which reflect at all an intellectual order analogous with or related to our own. "I have elaborated this criticism," he says, "with the intention of emphasizing the need for studying the changes which have gone on, and are ever going on, in organic bodies from an exclusively physical point of view."* And so, new formulæ are constructed to explain, and to illustrate how this is to be done. "Survival" suggesting the "human view" of life and death, must be dismissed. How, then, are they to be described? They are "certain sets of phenomena." Their true physical character is "simply groups of

* Page 751. ("Popular Science Monthly," vol. xxix, p. 56.)

changes." In thinking of a plant, for example, we must cease to speak of its living or dying. "We must exclude all the ideas associated with the words life or death." * What we do know, physically, is thus defined: "That there go on in the plant certain interdependent processes in presence of certain aiding or hindering influences outside of it; and that in some cases a difference of structure or a favorable set of circumstances allows these interdependent processes to go on for longer periods than in other cases." How luminous! Milton spoke of his own blindness as "knowledge at one entrance quite shut out." But here we have a specimen of the verbal devices by which knowledge at all entrances may be carefully excluded. Life is certain "interdependent processes." Yes, certainly. But so is death. And so is everything else that we know of or can conceive. The words devised by Mr. Herbert Spencer to represent the "purely physical" view of life and death, are words which present no view at all. They are simply a thick fog in which nothing can be seen. Except in virtue of this character of general opacity, they are wholly useless for Mr. Spencer's own purpose as well as for every other. He seeks to exclude mind. But he fails to do so. He seems to think that when he has found a collocation of words which do not expressly convey some particular idea, he has therein found words in which that idea is excluded. This is not so. Words may be so vague and abstract as to signify anything or nothing. If under the word "fitness" human ideas of adjustment and design are apt to insinuate themselves, assuredly the same ideas not only may, but must, be comprehended under such a phrase as "interdependent processes." Painting, for example, is an interdependent process, and both in its execution and results its interdependence lies in purely physical combinations of visible and touchable materials. Yet Sir Thomas Lawrence spoke with literal truth when he snubbed a questioner as to the mechanics of his art by telling him that he mixed his colors with brains. The whole of chemical science consists in the knowledge of interdependent processes which are (what we call) purely physical, while the whole science of applied chemistry involves those other interdependent processes which involve the co-operation of the human mind and will.

We have, then, in this new phrase a perfect specimen of one favorite method of Mr. Herbert Spencer in his dealing with such subjects; and the weapon of analysis which he turns so successfully against his own old phrase when he wishes to abandon it, can be turned with equal success not only against all substitutes for it, but against the whole method of reasoning of which it was an example. The verbal structures of definition which

* Page 751. ("Popular Science Monthly," vol. xxix, p. 55.)

abound in his writings always remind me of certain cloud-forms which may sometimes be seen in the western sky, especially over horizons of the sea. They are often most glorious and imposing. Great lines of towers and of far-reaching battlements give the impression at moments of mountainous solidity and strength. But as we gaze upon them with wonder, and as we fix upon them a closely attentive eye, the edges are seen to be as unsteady as at first they appeared to be enduring. If we attempt to draw them we find that they melt into each other, and that not a single outline is steady for a second. In a few minutes whole masses which had filled the eye with their majesty, and with impressions as of the everlasting hills, dissolve themselves into vapor and melt away.

Such are the cloud-castles which mount upon the intellectual horizon as we scan it in the representations of the mechanical philosophy. Nothing can be more fallacious than the habit of building up definitions out of words so vague and abstract that they may signify any one of a dozen different things, and the whole plausibility of which consists in the ambiguity of their meanings. It is a habit too which finds exercise in the alternate amusement of wiping out of words which have a definite and familiar sense, everything that constitutes their force and power. Let us take, for example, the word "function." There is no word, perhaps, applicable to our intellectual apprehensions of the organic world, which is more full of meaning, or of meaning which satisfies more thoroughly the many faculties concerned in the vision and description of its facts. The very idea of an organ is that of an apparatus for the doing of some definite work, which is its function. For the very reason of this richness and fullness of meaning, in this word conjoined with great precision, it is unfitted for use in the vapory cloud-castles of definition which are the boasted fortresses of ideas purely physical. And yet function is a word which it is most difficult to dispense with. The only alternative is to reduce it to some definition which wipes out all its special signification. Accordingly, Mr. Herbert Spencer has defined function as a word equivalent to the phrase "transformations of motion"*—a phrase perfectly vague, abstract, and equally applicable to function or to the destruction of it, to the processes of death or the processes of life, to the phenomena of heat, of light, or of electricity, and completely denuded of all the special meanings which respond to our perception of a whole class of special facts.

Of course the attempt breaks down completely to describe the facts of nature in words too vague for the purpose, or in words rendered sterile by artificial eliminations. It is not Dar-

* "Principles of Biology," vol. i, p. 4.

win only, who had at least no dogma on this subject to bind him —it is Mr. Spencer himself who continually breaks down in the attempt, far more completely than he now admits he failed in the "survival of the fittest." The human element involved or suggested in the idea of fitness is nothing to the humanity, or "anthropocentricity," of the expressions into which he slips, perhaps unawares, when he is face to face with those requisites of language which arise out of the facts of observation, and out of the necessities of thought. Thus in the midst of an elaborate attempt to explain in purely chemical and physical aspects the composition and attributes of protein, or protoplasm—assumed to be the fundamental substance of all organisms—he breaks out into the following sentence, charged with teleological phraseology: "So that while the composite atoms of which organic tissues are built up possess that low molecular mobility fitting them for plastic purposes, it results from the extreme molecular mobilities of their constituents, that the waste products of vital activity escape as fast as they are formed." * Now, what is the value of sentences such as this? As an explanation, or anything approaching to an explanation, of the wondrous alchemies of organic life, and especially of the digestive processes—of the appropriation, assimilation, and elimination of external matter —this sentence is poor and thin indeed. But whatever strength it has is entirely due to its recognition of the fact that not only the organism as a whole, but the very materials of which it is "built up," are all essentially adaptations which are in the nature of "purposes," being indeed contrivances of the most complicated kinds for the discharge of functions of a very special character.

What, then, is the great reform which these new papers are intended to effect in our conception of the factors in organic evolution? The popular and accepted idea of them has been largely founded on the language of Darwin and of Mr. Spencer himself. But that language has been deceptive. The needed reform consists in the more complete expulsion of every element that is "anthropocentric." In order to interpret Nature we must stand outside ourselves. The eye with which we look upon her phenomena must be cut off, as it were, from the brain behind it. The correspondences which we see, or think we see, between the system of things outside of us and the system of things inside of us, which is the structure of our own intelligence, are to be discarded. This is the luminous conception of the new philosophy. Science has hitherto been conceived to be the reduction of natural phenomena to an intelligible order. But the reformed idea is now to be that our own intelligence is

* "Principles of Biology," vol. i, p. 24.

the one abounding fountain of error and deception. It is not merely to be disciplined and corrected, but it is to be eliminated. It is to be hounded off and shouted down.

It is very clear what all this must end in. The demand made upon us in its literal fullness is impossible and absurd. We can not stand outside ourselves. We can not look with eyes other than our own. We can not think except with the faculties of our own intellectual nature. It is impossible, and, if it were possible, it would be absurd. We are ourselves a part of nature—born in it, and born of it. The analogies which the disciplined intellect sees in external nature are therefore not presumably false, but presumably true, or at the least substantially representative of the truth.

But the new veto on anthropocentric thought, although helpless to expel it, is quite competent to cripple and degrade it. It can not exclude our own faculties; but it may select and favor the lowest, the humblest, the most elementary, the most blunt, the least perceptive. It may silence the highest, the acutest, the most penetrating, the most intuitive, those most in harmony with the highest energies in the world around us. All this the new doctrine may do, and does.

Accordingly, the very first instance given to us of the new philosophy is a striking illustration of its effects. It fixes the attention on mere outward and external things. It seeks for the first and best explanation of organic beings in the mere mechanical effects of their surroundings. The physical forces which act upon them from outside—the water or the air that bathes them—the impacts of ethereal undulations in the form of light, the vibrations of matter in contact with them in the form of heat—these are conceived of as the agencies principally concerned. The analogies suggested are of the rudest kind. Old cannon-balls rust in concentric flakes. Rocks weather into such forms as rocking stones.* But the grand illustration is taken from the pebbles of the Chesil beach.† These are to introduce us to the true physical conception of the wonderful phenomena of organic life. May not the unity of the vertebrate skeleton, through an immense variety of creatures, be typified by the roundness and smoothness common to the stones rolled along the southern beaches of England from Devonshire to Weymouth? The diversities of those creatures, again, however multitudinous in character, may they not all be pictured as analogous with the varying sizes into which water sifts and sorts the sizes of rolled stones?

But presently we see in another form the work of "natural

* Page 755. ("Popular Science Monthly," vol. xxix, p. 60.)

† Page 752. ("Popular Science Monthly," vol. xxix, p. 57.)

selection" by a mind deliberately divesting itself of its own higher faculties, and choosing in consequence to exert only those which are simple and almost infantile. The question naturally arises, What is the most universal peculiarity and distinction of organic forms? When we get rid of ourselves, when we stand outside of our own anthropocentric position, and consult only the faculties which are most purely physical, we shall be compelled to reply that the great specialty of organic forms is the "differentiation of their outside from their inside."* They have all an outside and an inside, and these are different. They begin with a cell, and a cell is a blob of jelly with a pellicle or thin membrane on the outside. Do we not see in this the mechanical action of the surrounding medium? The skin may come from a chill on the outside, or the pressure of the medium. Does not a little oil form itself into a sphere in water, or a little water into a drop in air? And so from one step to another, can not we conceive how particles of protein become cells, and how one cell gets stuck to another, and the groups to groups—all with insides and outsides "differentiated" from each other, and so they can all be pressed and compacted and squeezed together until the organism is completed? †

Such or such like are the images presented to enable us to conceive the purely physical view of the beginnings of life. Their own genesis is obvious. It is true that all or nearly all organisms have a skin. Most if not all of them begin, so far as seen by us, in a nucleated cell. The external wall of these cells is often a mere pellicle. It is true also that one essential idea of life is separation or segregation from all other things. This is an essential part of our ideas of individuality and of personality. If a pellicle or skin round a bit of protein be taken as the symbol of all that is involved in this idea of life, then "outness" and "inness" may be tolerated as a very rude image of one of the great peculiarities of all organic life. It may even be regarded as a symbol of the thoughts expressed in the solemn lines—

> "Eternal form shall still divide
> The eternal soul from all beside."

But if "outer" and "inner" are used to express the idea of some essential mechanical separation between different parts of the same organism, so that one part may be represented as more the result of surrounding forces than another—then this rude and mechanical illustration is not only empty, but profoundly erroneous. The forces which work in and upon organic life know

* Page 755. ("Popular Science Monthly," vol. xxix, p. 60.)

† Pages 756–758. ("Popular Science Monthly," vol. xxix, pp. 61–63.)

nothing of outness and inness. They shine through the materials which they build up and mold, as light shines through the clearest glass. Even the most purely physical of those concerned are independent of such relations. Gravitation knows nothing of inness and outness. The very air, which seems so external to us, does not merely bathe or lave the skin, but permeates the blood, and its elements are the very breath of life in every tissue of the body. The more secret forces of vitality deal at their will with outness and inness. The external surfaces of one stage are folded in and become most secret recesses at another. Organs which are outside in one animal, and are conspicuously flourished in the face of day with exquisite ornament of color and of structure,* are in another animal hid away and carefully covered up. Nay, there are many cases in which all these changes are conducted in the same animal at different periods of life, and during conscious and unconscious intervals the whole creature is reformed to fit it for new surroundings, for new media, and with new apparatuses adapted to them.

If Mr. Spencer wishes to cast any fresh light upon those factors of organic evolution respecting which he now confesses that Darwin's language and his own have been alike defective, he must fix our attention on something deeper than the differences between every organism and its own skin. His selection of this most superficial kind of difference as the first to dwell upon, is not merely wanting—it is erroneous. It hides and leads us off the scent of another kind of outsidedness and insidedness which is really and truly fundamental; namely, the insidedness, the self-containedness, of every organism as a whole with reference to all external forces. Nobody has pointed this out more clearly in former years than Mr. Spencer himself. The grand distinction between the organic and the inorganic lies in this—that the organic is not passive under the touch or impact of external force, but responds, if it responds at all, with the play of counter-forces which are essentially its own. Organic bodies are not simply moved. They move themselves. They have "self-mobility." † They are so constituted that even when an external force acts as an excitement or a stimulus, the organic forces which emerge and act are much more complex and important—so much so that as compared with the results produced by these organic forces the direct results of the incident forces are "quite obscured." ‡ Mr. Spencer even confesses that these two kinds of action are so different in their own nature that in strictness they "should not be dealt with together."

* As in the nudibranchiate mollusca.

† Page 757. ("Popular Science Monthly," vol. xxix, p. 62.)

‡ "Principles of Biology," vol. i, p. 43.

But he adds that "the impossibility of separating them compels us to disregard the distinction between them." This is a most lame excuse for the careless—and still worse excuse for the studied—use of ambiguous language which confounds the deepest distinctions in nature. It can not be admitted. All reasonings on nature would be hopeless unless we could separate in thought many things which are always conjoined in action; and this excuse is all the more to be rejected when the alleged impossibility of separation is used to cover an almost exclusive stress upon that one of the two kinds of action which is confessedly by far the feeblest, and of least account in the resulting work.

It seems to me, further, that there is another fatal fault in this attempt of Mr. Spencer to reform the language, and clear up the ideas of biological science. Besides the method of habitually using words so abstract as to be of necessity ambiguous—besides the further method of habitually expelling from definite words the only senses which give them value—Mr. Spencer often resorts, and does so conspicuously in this paper, to the scholastic plan of laying down purely verbal propositions and then arguing deductively from them as if they represented axiomatic truth. By the schoolmen this method was often legitimately applied to subjects which in their own nature admitted of its use, because those subjects were not physical but purely moral or religious, and in which consequently much depended on the clear expression of admitted principles of abstract truth. I will not venture to say that such verbal propositions embodying abstract ideas have absolutely no place in physical science. We know as a matter of fact that they have led some great men to the first conception of a good many physical truths; and it is a curious fact that Dr. Joule, who in our own day has been the first to establish the idea of the doctrine of the conservation of energy by proving through rigorous experiment the mechanical equivalent of heat, has said that "we might reason *a priori* that the absolute destruction of living force can not possibly take place because it is manifestly absurd to suppose that the powers with which God has endowed matter can be destroyed, any more than they can be created, by man's agency." *

Believing as I do in the inseparable unity which binds us to all the verities of nature, I should be the last to proscribe the careful use of our own abstract conceptions. But it is quite certain and is now universally admitted that the methods of Thomas Aquinas in his "Summa" are full of danger when they

* In a lecture delivered at Manchester, April 28, 1847. See "Strictures on the Sermon," etc., by B. St. J. B. Joule, J. P., a pamphlet published 1887 (J. Heywood, Manchester).

are used in physical investigation. Yet as regards at least the tone of dogma and authority, and also as regards the method of reasoning, we have from Mr. Spencer in this paper the following wonderful specimen of scholastic teaching on the profoundest questions of organic structure: "At first protoplasm *could have* no proclivities to one or other arrangement of parts; unless indeed a purely mechanical proclivity toward a spherical form when suspended in a liquid. At the outset it *must have been* passive. In respect of its passivity, primitive organic matter *must have been* like inorganic matter. No such thing as spontaneous variation *could have* occurred in it; for variation implies some habitual course of change from which it is a divergence, and is therefore excluded where there is no habitual course of change." What possible knowledge can Mr. Spencer possess of "primitive organic matter"? What possible grounds can he have for assertions as to what it *must have been*, and what it *must have done?* Surely this is scholasticism with a vengeance; its words, its assumptions, and its claims of logical necessity being all equally hazy, inconclusive, and absolutely antagonistic to the spirit of true physical science.

There is a passing sentence in one of Darwin's works * which will often recur to the memory of those who have observed it. Speaking of the teleological or theological methods of describing nature, he says that these can be made to explain anything. At first sight this may seem a strange objection to any intelligible method—that it is too widely applicable. But Darwin's meaning is in its own sphere as true as it is important. An explanation which is good for everything in general, is good for nothing in particular. Explanations which are indiscriminate can hardly be also special and distinguishing. In their very generality they may be true, but the truth must be as general as the terms in which it is expressed. Thus the common phrase which we are in the habit of applying to the wonderful adaptations of organic life when we call them "provisions of nature," is a phrase of this kind. It satisfies certain faculties of the mind, and these the highest, but it affords no satisfaction at all to those other faculties which ask not why, but how, these adaptations are effected. It is an explanation applicable to all adaptations equally, and to no one of them specially. It takes no notice whatever of the question, How? It does not concern itself at all with physical causes.

Darwin saw this clearly of such methods of explanation. But he did not see that precisely the same objection lies against his own. The great group of ideas metaphorically involved in his phrase of natural selection, and not successfully eliminated in

* I have mislaid the reference, and quote from memory.

the summary of it—survival of the fittest—is a group of the widest generality. It may be used to account for anything. The successful application of it to any organic adaptation, however special and peculiar, is so easy as to become a mere trick. We have only to assume the introduction of some primordial organisms—one or more—already formed with all the special powers and functions of organic life; we have only to assume the inscrutable action of heredity; we have only to assume, further, that it originates difference as well as transmits likeness; we have only to assume, still further, that the variations so originated are almost infinite in variety, and that some of them are almost sure, at some time or another, to "turn up trumps," or in other words to be accidentally in a useful direction; we have only to assume, again, that these will be somehow continued and developed through embryotic stages until they are fit for service; we have only to assume, again, that there are adjustments by which serviceability, when transmuted into actual use, has power still further to improve all adaptations by some process of self-edification; then, making all these assumptions, we may explain anything and everything in the organic world. But in such a series of assumptions we do not speak the language of true physical causation. This is what Mr. Spencer now confesses. "Natural selection," he says, "could operate only under subjection." * This is a prolific truth. It might have been discovered sooner. Natural selection could only select among things prepared for and presented to its choice. How—from what physical causes—did these come? Mr. Spencer's reply is, historically speaking, retrograde. He goes back to Lamarck, he reverts to "use and disuse," to "environment"—to surroundings—to the "medium and its contents." † These again are mere phrases to cover the nakedness of our own ignorance. But I for one am thankful for the conclusion arrived at by a mind so acute and so analytical as that of Mr. Spencer, that "among biologists the beliefs concerning the origin of species have assumed too much the character of a creed, and that while becoming settled they have been narrowed. So far from further broadening that broader view which Darwin reached as he grew older, his followers appear to have retrograded toward a more restricted view than he ever expressed." The evil must have gone far indeed when this great apostle of Evolution has to plead so laboriously and so humbly "that it is yet far too soon to close the inquiry concerning the causes of organic evolution." Too soon indeed! That such an assumption should have been possible, and that it is virtually made, is part of the Great Confession to which I have desired to direct attention. I hope it

* Page 768. ("Popular Science Monthly," vol. xxix, p. 201.) † Ibid.

will tend to redeem the work of the greatest natural observer who has ever lived from the great misuse which has been often made of it. There is no real disparagement of that work in saying that the phrase which embalmed it is metaphorical. The very highest truths are conveyed in metaphor. The confession of Mr. Spencer is fatal only to claims which never ought to have been made. Natural selection represents no physical causation whatever except that connected with heredity. Physically it explains the origin of nothing. But the metaphorical elements which Mr. Spencer wishes to eliminate are of the highest value. They refer us directly to those supreme causes to which the physical forces are "under subjection." They express in some small degree that inexhaustible wealth of primordial inception, of subsequent development, and of continuous adjustment, upon which alone selection can begin to operate. These are the supreme facts in nature. When this is clearly seen and thoroughly understood, Darwin's researches and speculations will no longer act as a barrier to further inquiry, as Mr. Spencer complains they now do. They will, on the contrary, be the most powerful stimulus to deeper inquiry, and to more healthy reasoning.—*Nineteenth Century.*

THE AMERICAN ROBIN AND HIS CONGENERS.

By Dr. SPENCER TROTTER.

OUR American robin is a thrush—the red-breasted thrush is his proper title—he occupies a high position in the scale of bird-life, and possesses some very interesting records of his family history. When our forefathers first came over they found the frank, hearty bird with the russet breast ready to make friends with them, to stay about the clearings and around their rough cabins, cheering them with the strong, hopeful song that has ever gladdened the heart with its vigor and fullness of promise. With what joy the pioneers must have welcomed the first spring that brought the robins back after the long, dreary winter! To this day the first robin of the spring creates a sensation, coming, as he often does, amid the ice and the snow and the rough wind, and not a leaf on the trees. The early settlers called him "robin" from his red breast, no doubt, and his confiding ways, after the trusty little warbler so dear to their hearts in the old home across the sea. And so it has been "robin" ever since, although our bird is but distantly related to the little robin-redbreast of the Old World, who belongs to the warblers —another branch of the family.

By virtue of being a thrush, our robin enjoys a very extensive range of country for his habitat. From the Atlantic to the Pacific, across the continent, from the shores of the Arctic Ocean to Mexico and Central America, he is found abundantly, breeding throughout the forest limits of this wide area, and building the same nest of dried grass, roots, and plastered mud about every homestead in the land. Although a bird of the woodland, like all the thrushes, he yet prefers the garden and the orchard —even the trees that stand in the midst of the bustling city hold his nest. Insectivorous by nature, but varying his diet largely with the small, wild berries of the woods, the robin has become, since man's invasion, a lover of fruit, keeping pace with man in the cultivation of his taste. The excellence of his taste can not be denied. He takes the biggest cherries of the most approved varieties, and the luscious strawberries are his delight. Yet for all the fruit he eats he repays the horticulturist double by devouring threefold more of insect-life that would ultimately cover and destroy the trees, leaf, root, and branch. Fortunate it is that we have recognized his valuable service, and protected him by legislation.

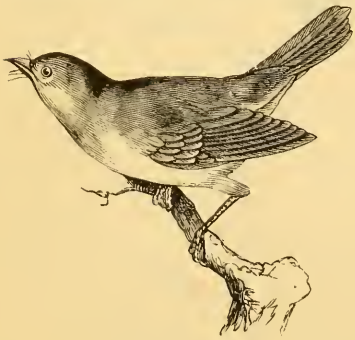
American Robin.

The true thrushes—and the robin may be taken as a type—present some very interesting features in their development, characters, and geographical distribution, a study of which throws light not only upon the history of the birds themselves, but also upon several widely different subjects.

The thrushes belong to the most highly organized group of birds—the *Passeres*—and are farthest removed in structure from the early reptiloid forms. They possess the most complete vocal apparatus—a syrinx—situated at the lower end of the windpipe, with five intrinsic pairs of muscles. The wing has undergone a reduction in the number of its primaries or quill-feathers growing from the long finger, there being ten of these, the first one short and abortive, so that the thrushes may be looked upon as still advancing toward the highest type of wing-structure, that of *nine* primaries. In conjunction with this, the foot or leg is "booted"—i. e., covered by an unbroken plate of hard, leathery skin, not reticulated and scaled, as in other forms. A decided change has also taken place in the "molt," or shedding of

feathers; the autumnal molt being the only complete process, while the spring change is effected simply by the "casting" off of the broken points of feathers in the worn plumage. The young of all the thrushes are spotted in their nestling dress, but never carry it beyond the first autumn, assuming the full plumage of the old birds after the first molt, so that "a bird of the year" in the late fall and winter is scarcely distinguishable from its parents. Any one who is familiar with the young robins hopping about the lawn in the early summer, with their spotted breasts and mottled backs, may have wondered what became of them by October.

The thrushes are migratory birds in the temperate zone, as the nature of their food demands, partaking in the general north and south movement during the spring and fall tides of migration. Though not strictly gregarious, many of the species associate in loose flocks, on the approach of autumn, and forage over the country in quest of food. We are all familiar with the flocks of robins in the fall, scattering overhead, or in the gum-trees feasting on the ripe, black fruit. They are for the most part arboreal, living largely among the trees, but some of the species build nests on the ground, or in the undergrowth just above it, and all of them frequent the ground at times when food is to be obtained there. Being among the most highly organized of birds, the thrushes are consequently rapid livers, possessing a high degree of vitality, and consuming a very large proportion of oxygen. Great feeders, strong of wing and stout of heart, with warm, fast-flowing blood and high temperature, they are, in every sense of the word, alive to their environment.



ROBIN-REDBREAST.

The robin and his world-wide congeners form the genus *Turdus*, or true thrushes, comprising upward of fifty well-defined species distributed throughout the forest regions of the globe, excepting Australia and New Zealand, where they are replaced by an allied group.

In the palæarctic region of the Old World four widely distributed species occur, all having spotted breasts in the adult plumage. The red-winged thrush breeds in the birch region, and throughout the upper belt of pines across Europe and Asia, from the Atlantic to the Pacific. He is rare east of the valley of the Yenisei, but extends his wanderings northward as far as

latitude 71° beyond the forest limit. The red-wing winters in southern and western Europe and the British Islands.

The blue-backed thrush, or "field-fare," has a range somewhat similar with the above species; Asiatic individuals migrating in winter to Cashmere, Turkistan, and the northwestern portion of India. The missel-thrush breeds throughout central Europe, ranging eastward to the northwestern slopes of the Himalayas. In such a mild climate as Great Britain offers, he remains the year round, but the majority of individuals winter in southern Europe, Persia, and North Africa. The song-thrush is another palæarctic form, breeding eastward to the Yenisei Valley, and in Norway wandering beyond the Arctic Circle. He has a near relative inhabiting northern and western China, known as Père David's thrush, in honor of a good monk who devoted much time to the study of ornithology.

SONG-THRUSH.

There are two spotted-breasted thrushes restricted each to a certain island, and found nowhere else: the Anjuan thrush, inhabiting one of the islands of the Comoro group, lying between Madagascar and the African coast; and the St. Thomas thrush, from the island of that name, in the Gulf of Guinea.

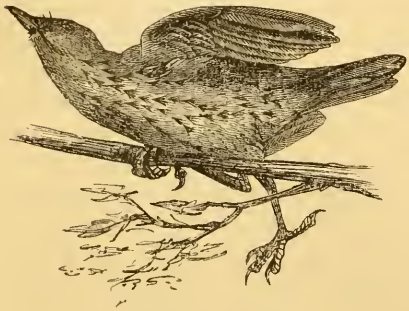
In the New World the nearctic, or North American region, possesses several species of spotted-breasted thrushes breeding throughout its forest area. Notable among these are the wood-thrush, whose mellow, rippling music we know and love so well; the hermit, the olive-backed, the gray-cheeked, and tawny thrushes—spring and fall migrants passing through our woods in May and October.

In contrast to the spotted-breasted species, there are a number of thrushes, and among them the robin, which are solidly colored underneath, a few spots being confined to the throat. This difference in color-pattern has undoubtedly arisen far back in the history of the group from some environing influence. The young of these solid-colored thrushes are all spotted like the rest, and, since the young of all animals tend to revert toward ancestral forms and conditions, the spotted-breasted species may be looked upon as representing the more primitive type of thrush. A further proof of this is found in the two spotted-breasted thrushes inhabiting the islands above men-

tioned, which from their isolated habitat are undoubtedly of considerable antiquity as species. Our robin is the only representative of the thrushes with solid-colored breasts found in North America, but a host of them occur in South America and some in Africa.

This contrast between the northern and southern continents of the New World, or, to speak zoölogically, between the nearctic and neotropical regions, in the number of species of thrush, has its solution in the peculiarity and variety of physical conditions offered by South America. The ranges of the species inhabiting the great forests of the equatorial zone are in the majority of instances restricted to comparatively limited areas. The varied conditions offered by high mountain-ranges and deep, low-lying forests, tend to the creation of new varieties or local races, which are consequently limited to certain narrow areas, and a particular species is often thus represented by several extreme forms. In temperate North America, on the other hand, the fewer species are kept true by migration, which tends to equalize surrounding conditions.

In northern South America, the valley of the Amazon, and the forests of Brazil, three distinct varieties of the white-throated thrush occur. The common South American thrush, a comparatively widely ranging species, reaching southward to Chili, has an extreme form in the northwest. The Sabian thrush is another species which has split up into several forms under the influence of local conditions. No region in the world is so rich in the number and variety of its passerine birds. In the south temperate portion of the continent the species of thrush are more uniform, and very few varieties are found.



Wood-Thrush.

Africa has several well-defined representatives of the solid-colored-breasted thrushes. The Zanzibar thrush and the Abyssinian thrush are eastern forms; in the west, the Ethiopian and Senegambian thrushes are found; while to the southward the olive-thrush, Cabani's thrush, and the Kurichane thrush range throughout the Transvaal, Caffraria and Damara Land, the Bechuana country, and the Cape.

The facts, as they are presented to-day by this interesting group of birds, become very significant when viewed in the light of evolution. The world-wide distribution, large number of

established species, and high degree of development which the thrushes have attained, denote their comparative antiquity as a group of birds. Time has been the important factor in establishing the species, and enabling them to live far and wide in harmony with diverse conditions of life. It would be difficult to ascertain the original center of their development—probably one of the great land-masses, as the Euro-Asiatic continent, whence the early forms have spread to other portions of the earth, there to break up into new varieties and species under the action of changing environments.

Where other forms have succumbed in the struggle for life these have lived on, until now, the almost perfect wing and foot; the vital strength that holds the plumage for a year before it is shed, and also enables the mating pair to rear three goodly broods each spring; the vocal development, the omnivorous diet, the abundance and world-wide distribution of species, tell the story of how the robin and his congeners have come to be what they are — a dominant group in the animal life of the earth.

THE RELATION OF EVOLUTION TO MATERIALISM.*

By Professor JOSEPH LE CONTE.

IT was seen in the sketch previously given † that, after every struggle between theology and science, there has been a readjustment of some beliefs, a giving up of some notions which really had nothing to do with religion in a proper sense, but which had become so *associated* with religious belief as to be confounded with the latter—a giving up of some line of defense which ought never to have been held, because not within the rightful domain of theology at all. Until the present the whole difficulty has been the result of misconception, and Christianity has emerged from every struggle only strengthened and purified, by casting off an obstructing shell which hindered its growth. But the present struggle seems to many an entirely different and far more serious matter. To many it seems no longer a struggle of theology, but of essential religion itself—a deadly life-and-death struggle between religion and materialism. To many, both skeptics and Christians, evolution seems to be synonymous with blank materialism, and therefore cuts up by the roots every form of religion by denying the existence of God and the fact of immortality. That the enemies of religion, if

* From "Evolution and its Relation to Religious Thought." By Professor Joseph Le Conte. New York: D. Appleton & Co., 1888.

† "Popular Science Monthly" for January, 1888.

there be any such, should assume and insist on this identity, and thus carry over the whole accumulated evidence of evolution as a demonstration of materialism, although wholly unwarranted, is not so surprising; but what shall we say of the incredible folly of her friends in admitting the same identity?

A little reflection will explain this. There can be no doubt that there is at present a strong and to many an overwhelming tendency toward materialism. The amazing achievements of modern science; the absorption of intellectual energy in the investigation of external Nature and the laws of matter have created a current in that direction so strong that of those who feel its influence—of those who do not stay at home, shut up in their creeds, but walk abroad in the light of modern thought—it sweeps away and bears on its bosom all but the strongest and most reflective minds. Materialism has thus become a fashion of thought; and, like all fashions, must be guarded against. This tendency has been created and is now guided by science. Just at this time it is strongest in the department of biology, and especially is evolution its stronghold. This theory is supposed by many to be simply demonstrative of materialism. Once it was the theory of gravitation which seemed demonstrative of materialism. The sustentation of the universe by law seemed to imply that Nature operates itself and needs no God. That time is past. Now it is evolution and creation by law. This will also pass. The theory seems to many the most materialistic of all scientific doctrine only because it is the *last* which is claimed by materialism, and the absurdity of the claim is not yet made clear to many.

The truth is, there is no such necessary connection between evolution and materialism as is imagined by some. There is no difference in this respect between evolution and any other law of Nature. In evolution, it is true, the last barrier is broken down, and the whole domain of Nature is now subject to law; but it is only *the last;* the march of science has been in the same direction all the time. In a word, evolution is not only not identical with materialism, but, to the deep thinker, it has not added a feather's weight to its probability or reasonableness. Evolution is one thing and materialism quite another. The one is an established law of Nature, the other an unwarranted and hasty inference from that law. Let no one imagine, as he is conducted by the materialistic scientist in the paths of evolution from the inorganic to the organic, from the organic to the animate, from the animate to the rational and moral, until he lands, as it seems to him, logically and inevitably, in universal materialism —let no such one imagine that he has walked all the way in the domain of science. He has stepped across the boundary into the

domain of philosophy. But, on account of the strong tendency to materialism and the skillful guidance of his leaders, there seems to be no such boundary; he does not distinguish between the inductions of science and the inferences of a shallow philosophy; the whole is accredited to science, and the final conclusion seems to carry with it all the certainty which belongs to scientific results. The fact that these materialistic conclusions are reached by some of the foremost scientists of the present day adds nothing to their probability. In a question of science, viz., the law of evolution, their authority is deservedly high, but in a question of philosophy, viz., materialism, it is far otherwise. If the pure scientists smile when theological philosophers, unacquainted with the methods of science, undertake to dogmatize on the subject of evolution, they must pardon the philosophers if they also smile when the pure scientists imagine that they can at once solve questions in philosophy which have agitated the human mind from the earliest times. I am anxious to show the absurdity of this materialistic conclusion, but I shall try to do so, not by any labored argument, but by a few simple illustrations:

1. It is curious to observe how, when the question is concerning Nature, we no sooner find out how a thing is made than we immediately exclaim, "It is not made at all—it became so of itself!" So long as we knew not how worlds were made, we of course concluded they must have been created; but, so soon as science showed *how* it was probably done, immediately we say we were mistaken—they were not made at all. So also, so long as we could not imagine how new organic forms originated, we were willing to believe they were created; but, so soon as we find that they originated by evolution, many at once say, "We were mistaken—no creator is necessary at all." Is this so when the question is concerning a work of man? Yes, of one kind—viz., the work of the magician. Here, indeed, we believe in him, and are delighted with his work, until we know how it is done, and then all our faith and wonder cease. But in any honest work it is not so; but, on the contrary, when we understand how it is done, stupid wonder is changed into intellectual delight. Does it not seem, then, that to most people God is a mere wonder-worker, a chief magician? But the mission of science is to show us how things are done. Is it any wonder, then, that to such persons science is constantly destroying their superstitious illusions? But if God is an honest worker, according to reason—i. e., according to law—ought not science rather to change gaping wonder into intelligent delight—superstition into rational worship?

2. Again, it is curious to observe how an *old truth*, if it come

only in a *new form*, often strikes us as something unheard of, and even as paradoxical and almost impossible. A little over thirty years ago a little philosophical toy, the gyroscope, was introduced and became very common. At first sight it seems to violate all mechanical laws and set at naught the law of gravitation itself. A heavy brass wheel, four to five inches in diameter, at the end of a horizontal axle, six or eight inches long, is set rotating rapidly, and then the free end of the axis is supported by a string or otherwise. The wheel remains suspended in the air while slowly gyrating. What mysterious force sustains the wheel when its only point of support is at the end of the axle, six or eight inches away? Scientific and popular literature were flooded with explanations of this seeming paradox. And yet it was nothing new. The boy's top, that spins and leans and will not fall, although solicited by gravity, so long as it spins, which we have seen all our lives without special wonder, is precisely the same thing.

Now, evolution is no new thing, but an old familiar truth; but, coming now in a new and questionable shape, lo, how it startles us out of our propriety! Origin of forms by evolution is going on everywhere about us, both in the inorganic and the organic world. In its more familiar forms it had never occurred to most of us that it was a scientific refutation of the existence of God, that it was a demonstration of materialism. But now it is pushed one step farther in the direction it has always been going—it is made to include also the origin of species—only a little change in its form, and lo, how we start! To the deep thinker, now and always, there is and has been the alternative—materialism or theism. God operates Nature or Nature operates itself; but evolution puts no new phase on this old question. For example, the origin of the individual by evolution. Everybody knows that every one of us individually became what we now are by a slow process of evolution from a microscopic spherule of protoplasm, and yet this did not interfere with the idea of God as our individual maker. Why, then, should the discovery that the species (or first individuals of each kind) originated by evolution destroy our belief in God as the creator of species?

3. It is curious and very interesting to observe the manner in which vexed questions are always finally settled, if settled at all. All vexed questions—i. e., questions which have tasked the powers of the greatest minds age after age—are such only because there is a real truth on both sides. Pure, unmixed error does not live to plague us long. Error, when it continues to live, does so by virtue of a germ of truth contained. Great questions, therefore, continue to be argued *pro* and *con* from age to age, because each side is in a sense—i. e., from its own point of view

—true, but wrong in excluding the other point of view; and a true solution, a true rational philosophy, will always be found in a view which combines and reconciles the two partial, mutually excluding views, showing in what they are true and in what they are false—explaining their differences by transcending them. This is so universal and far-reaching a principle that I am sure I will be pardoned for illustrating it in the homeliest and tritest fashion. I will do so by means of the shield with the diverse sides, giving the story and construing it, however, in my own way. There is, apparently, no limit to the amount of rich marrow of truth that may be extracted from these dry bones of popular proverbs and fables by patient turning and gnawing.

We all remember, then, the famous dispute concerning the shield, with its sides of different colors, which we shall here call white and black. We all remember how, after vain attempts to discover the truth by dispute, it was agreed to try the scientific method of investigation. We all remember the surprising result. Both parties to the dispute were right and both were wrong. Each was right from his point of view, but wrong in excluding the other point of view. Each was right in what he asserted, and each wrong in what he denied; and the complete truth was the combination of the partial truths and the elimination of the partial errors. But we must not make the mistake of supposing that truth consists in *compromise.* There is an old adage that truth lies in the middle between antagonistic extremes. But it seems to us that this is the place of *safety,* not of truth. This is the favorite adage, therefore, of the timid man, the time-server, the fence-man, not the truth-seeker. Suppose there had been on the occasion mentioned above one of these fence-philosophers. He would have said: "These disputants are equally intelligent and equally valiant. One side says the shield is white, the other that it is black; now truth lies in the middle; therefore, I conclude the shield is gray or neutral tint, or a sort of pepper-and-salt." Do we not see that he is the only man who has no truth in him? No; truth is no heterogeneous mixture of opposite extremes, but a stereoscopic combination of two surface views into one solid reality.

Now, the same is true of all vexed questions, and I have given this trite fable again only to apply it to the case in hand.

There are three possible views concerning the origin of organic forms whether individual or specific. Two of these are opposite and mutually excluding; the third combining and reconciling. For example, take the individual. There are three theories concerning the origin of the individual. The first is that of the pious child who thinks that he was made very much as he himself makes his dirt-pies; the second is that of the

street-gamin, or of Topsy, who says, "I was not made at all, I growed"; the third is that of most intelligent Christians—i. e., that we were made by a process of evolution. Observe that this latter combines and reconciles the other two, and is thus the more rational and philosophical. Now, there are also three exactly corresponding theories concerning the origin of species. The first is that of many pious persons and many intelligent clergymen, who say that species were made at once by the Divine hand *without natural process.* The second is that of the materialists, who say that species were not made at all, they were derived, "they growed." The third is that of the theistic evolutionists, who think that they were *created* by a process of evolution—who believe that making is not inconsistent with growing. The one asserts the Divine agency, but denies natural process; the second asserts the natural process, but denies Divine agency; the third asserts *Divine agency by natural process.* Of the first two, observe, both are right and both wrong; each view is right in what it asserts, and wrong in what it denies—each is right from its own point of view, but wrong in excluding the other point of view. The third is the only true rational solution, for it includes, combines, and reconciles the other two; showing wherein each is right and wherein wrong. It is the combination of the two partial truths, and the elimination of the partial errors. But let us not fail to do perfect justice. The first two views of origin, whether of the individual or of the species, are indeed both partly wrong as well as partly right; but the view of the pious child and of the Christian contains by far the more essential truth. Of the two sides of the shield, theirs is at least the whiter and more beautiful.

But, alas! the great bar to a speedy settlement of this question and the adoption of a rational philosophy is not in the head but in the heart—is not in the reason but in pride of opinion, self-conceit, dogmatism. The rarest of all gifts is a truly tolerant, rational spirit. In all our gettings let us strive to get this, for *it* alone is true wisdom. But we must not imagine that all the dogmatism is on one side, and that the theological. Many seem to think that theology has a "*pre-emptive right*" to dogmatism. If so, then modern materialistic science has "*jumped the claim.*" Dogmatism has its roots deep-bedded in the human heart. It showed itself first in the domain of theology, because there was the seat of power. In modern times it has gone over to the side of science, because here now is the place of power and fashion. There are *two dogmatisms,* both equally opposed to the true rational spirit, viz., the old theological and the new scientific. The old clings fondly to old things, only because they are old; the new grasps eagerly after new things, only because

they are new. True wisdom and true philosophy, on the contrary, try all things both old and new, and hold fast only to that which is good and true. The new dogmatism taunts the old for credulity and superstition; the old reproaches the new for levity and skepticism. But true wisdom perceives that they are both equally credulous and equally skeptical. The old is credulous of old ideas and skeptical of new; the new is skeptical of old ideas and credulous of new. Both deserve the unsparing rebuke of all right-minded men. The appropriate rebuke for the old dogmatism has been already put in the mouth of Job in the form of a bitter sneer: "No doubt ye are the people, and wisdom shall *die* with you." The appropriate rebuke for the new dogmatism, though not put into the mouth of any ancient prophet, ought to be uttered—I will undertake to utter it here. I would say to these modern materialists, "No doubt ye are the men, and wisdom and true philosophy were *born* with you."

Let it be observed that we are not here touching the general question of the personal agency of God in operating Nature. This we shall take up hereafter. All that we wish to insist on now is that the process and the law of evolution do not differ in their relation to materialism from all other processes and laws of Nature. If the sustentation of the universe by the law of gravitation does not disturb our belief in God as the sustainer of the universe, there is no reason why the origin of the universe by the law of evolution should disturb our faith in God as the creator of the universe. If the law of gravitation be regarded as the divine mode of sustentation, there is no reason why we should not regard the law of evolution as the divine process of creation. It is evident that if evolution be materialism, then is gravitation also materialism; then is every law of Nature and all science materialism. If there be any difference at all, it consists only in this: that, as already said, here is the *last* line of defense of the supporters of supernaturalism in the realm of Nature. But being the last line of defense—the last ditch—it is evident that a yielding here implies not a mere shifting of line, but a change of base; not a readjustment of details only, but a *reconstruction of Christian theology.* This, I believe, is indeed necessary. There can be little doubt in the mind of the thoughtful observer that we are even now on the eve of the greatest change in traditional views that has taken place since the birth of Christianity. But let no one be greatly disturbed thereby. For as then, so now, change comes not to destroy but to fulfill all our dearest hopes and aspirations; as then, so now, the germ of living truth has, in the course of ages, become so incrusted with meaningless traditions which stifle its growth, that it is necessary to break the shell to set it free; as then, so

now, it has become necessary to purge religious belief of dross in the form of trivialities and superstitions. This has ever been and ever will be the function of science. The essentials of religious faith it does not, it can not, touch, but it purifies and ennobles our conceptions of Deity, and thus elevates the whole plane of religious thought.

It will not, of course, be expected of me to give, even in briefest outline, a system of reconstructed Christian thought. Such an attempt would be wholly unbecoming. Time, very much time, and the co-operation of many minds, bringing contributions from many departments of thought, are necessary for this. In a word, it can only itself come by a gradual process of evolution. But from the point of view of science some very fundamental changes in traditional views are already plain. Of these the most fundamental and important are our ideas concerning God, Nature, and man in their relations to one another.

SOUND-SIGNALS AT SEA.

By ARNOLD BURGES JOHNSON.

THE difficulty in determining the true and exact direction of the sounds we hear meets us in various ways. The hunter hears the note of a bird, the hiss or whistle of a deer, and the sound indicates identity and proximity but not direction. The hunter waits for repeated renewal of the sound to ascertain its exact position, and even then verifies his audition by his vision. The hunter by his camp-fire may aim between the luminous dots of reflected light, which he knows to be the eyes of a wolf; but he would scarcely be able to aim at or even very near that spot on simply hearing the howl from the wolf that owns the eyes.

The plainsman hears a shout in the distance. He may recognize it as the voice of a comrade, and fix the general direction as north, east, south, or west, but hardly more. He may shout back, and the two may come together; but if it be dark and there is no fire or other signal, the shouting back and forth must be frequently repeated, and varied from a simple to a complex sound, that each may correct the error of his own audition, eliminate his personal equation, and the sound will appear to swing, pendulum-like, right and left, with shorter and shorter stroke, till the comrades come together.

The average child, returning from school, on entering the house calls, "Mamma!" The mother, perhaps, replies, "Yes!" "Where are you?" is the next question, and the reply informs the child not only as to the floor, but as to the room in which

the mother can be found. The child can not determine its mother's location by the sound of her voice. This exaggerated instance may be owing to the reflection of the sound, not only from the walls, but from the strata of air differing in temperature and humidity.

How many of us going to the next street, running at right angles to the car-tracks, can tell, from hearing the bell of the approaching street-car before the car comes in sight, whether that car is going north or south? It does not seem that animals can determine the direction of sound much better than man. The sleeping dog, roused by his master's call, is all abroad as to his master's location, and determines it by sight or scent, or both, frequently running in several different directions before hitting the right one. The deer, on being startled by the unseen hunter's tread, is not always right in his selection of the route to get out of harm's way. A flock of geese, ducks, or other birds, on hearing a gun, is as likely to fly toward as from the sportsman, if he has kept entirely out of sight, and the flash of his piece has not been seen.

It is a question whether the blind are better able to determine the direction of sound by ear than are seeing people. It is possible that their senses of touch and smell are so highly developed that their instantaneous action with that of the ear give them a decided advantage over seeing people in this matter. I have known a blind man to be so sensible of the current of air put in motion by the speaking of a single word in a room, that he could select the speaker by his location, though others were present. So, too, I have known a blind man to locate and identify the various people in the room, he saying he did it by the different scent evolved from each, the seeing people there not being sensible of any scent from any one. And yet he, when standing in the middle of the room with his nose stopped, could not give the direction of one single speaking person.

Prof. Alexander Graham Bell reports, in a paper he read before the American Association for the Advancement of Science at Saratoga in 1879, a series of experiments in binaural audition, showing, among other things, that direction can not be appreciated by monaural observation; that when the source of sound is at the nadir of the observer, the perception of its direction is absolutely unreliable, and that not one of the many on whom he tried the experiment had the slightest idea of the true direction of a sound produced beneath him.

We are so much accustomed to the aid of our other senses, especially that of sight, that we incline to give more value to audition in determining direction than it deserves. That is one reason why we err so largely when so placed that the eye can

not correct the error of the ear—in fact, many people seem to be unaware that they have any inability to locate sound by the ear until they have learned the fact by experience, and even then they appear to consider marked instances as abnormal.

It is sufficiently easy to account for aberrations of audition as to the direction of sound from objective causes, such as reflection, diffraction, and deflection of sound-waves. But it may also often be accounted for by what Prof. Henry called subjective causes, such as induce belief that an anticipated sound has come from a specified direction, when it has really come from quite another direction. Here the personal equation of the listener must be largely taken into consideration. The success of the ventriloquist may also depend upon subjective causes.

President Welling tells us something of how Prof. Henry, when at Princeton, induced subjective causes in his pupils, to their bewilderment, making them believe, for the moment, that a given sound came from a specified corner of the class-room, when it really came from quite a different direction.

Mariners are beginning to accept the fact that they may err in assigning the true direction to sound; but their ideas on the subject are still vague and indeterminate. Hence occur collisions between ships at sea, and lawsuits between their owners on shore. The collision at 10 P. M., on September 21, 1882, between the Dutch steamer Edam and the British steamer Lepanto, on George's Bank, Atlantic Ocean, when the former was sunk by the latter, resulted in a suit in the United States District Court at New York city, in which the case turned on an erroneous location of the Edam by the Lepanto, on hearing the sound of her fog-horn. The court dismissed the case with costs, holding that "an error of five points in locating a vessel's position by the sound of her whistle in a fog is not necessarily a fault under the proved aberrations in the course of sound." The judge, in his decision, quotes, among others, papers read before the Washington Philosophical Society as his authority for certain statements he makes as to these laws of sound bearing on the case.*

As it seems evident that the unassisted ear is likely to err in determining the location of sound, the question arises, Can the ear be aided in this matter? Apparently this is possible. Prof. Mayer, of the Institute of Technology at Hoboken, N. J., has, to a certain extent, solved this problem by the construction of an instrument called the "topophone," by the use of which President Morton, a member of the Lighthouse Board, was enabled to locate within ten degrees, or less than one compass-point, the sound of a fog-signal, when in the cabin of a steamer

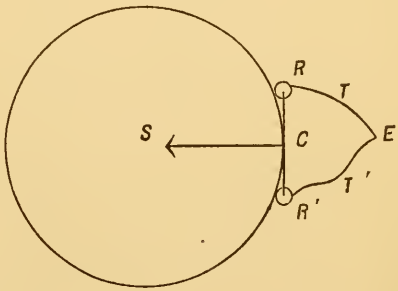
* See "Federal Reporter," October 28, 1884, p. 651.

at sea, seven miles away, and that, too, after he had purposely deprived himself of a knowledge of even the direction of the shore by having the steamer turned in her course from time to time. President Morton describes it thus:

This apparatus consisted of the following parts: A vertical rod passing through the roof of the deck-cabin, on the upper end of which was attached a horizontal bar carrying two adjustable resonators. Below these was a pointer set at right angles with the above bar. Rubber tubes passed through the roof of the cabin and were connected with a pair of ear-tubes. A handle attached to the vertical rod served to turn it in any direction.

The principle upon which the operation of this apparatus depends was first announced by Prof. Mayer in 1872 (see "American Journal of Science and Art," November, 1872, p. 387), and its general operation may be explained as follows:

Let S of the diagram be the source of a sound, and let the circle represent a wave-surface produced by that sound. On this surface all the molecules of air have, at the same instant, the same direction and the same velocity of vibratory motion. If we can accurately determine two points, R and R′, on this wave-surface, and this wave-surface be a spherical one, that is, be not deformed, then a perpendicular, C S, erected to the center of a chord drawn between these two points, will, when produced, pass through the source, S. The method consists in determining these two points on a sonorous wave-surface, as follows:



Let R and R′ be two resonators accurately tuned to the note given by the vibratory body at S. Suppose both resonators at the same instant on the wave-surface, then they both receive, at the same instant, the same phase of vibration, on the planes of their mouths. If two tubes of equal length lead from the resonators and join into one tube just before they reach the ear, E, then the sound-pulses will act together, being of the same phase, and the ear will receive double the action which it would if only one resonator were connected with the ear. But suppose that one of these tubes, T′, differs in length from the other tube, T, by one half of a wave-length of the tone given out by S, then the same pulses will no longer work together at E, but will be opposed to each other in their action, neutralizing each other's dynamic effect, and producing silence at the ear, E. This last condition is the one used in the apparatus above described.

We connect the two resonators, R and R′, by a rigid rod, and it is evident, if a pointer be placed at the center of this rod at right angles to its length, that when the resonators, R and R′, are on the wave-surface, the rod, C S, will point toward the source of sound at S. The rigid rod connecting the resonators, R and R′, turns on a vertical rod passing through C. This arrangement was described by Prof. Mayer before the National Academy in April, 1876.

While this contrivance may not yet be entirely practicable, its use, as detailed, makes the fact evident that some apparatus

can be arranged by which the aberration in the audition of the mariner may be so corrected that he can locate the source of the sound which is made to assure his safety, but which, misheard, may, as in the case of the Edam and Lepanto, insure his destruction.

It seems evident from President Morton's statements that if the fog-signals of the maritime world, or even of one country, or even those located in the approaches to one of our great harbors, were tuned to one note, and if the ships frequenting those waters were fitted with topophones, or some similar instrument, arranged so as to be in unison with the fog-signals, that aberrations in audition, at least as to direction, might be corrected, so as to determine the location of sound to within at least one compass-point.

Since the development of the topophone a number of other instruments have been invented for determining for the mariner the direction of sound made to warn him from danger. For some time some of our best ocean-steamers have been supplied with an instrument giving sounds of wonderful pitch and intensity, called the siren. It was adapted from the instrument invented by Cagniard de la Tour, by A. and F. Brown, of the New York City Progress Works, under the guidance of Prof. Henry, at the instance and for the use of the United States Lighthouse Establishment, which also adopted it for use as a fog-signal. The siren of the first class consists of a huge trumpet, somewhat of the size and shape used by Daboll, with a wide mouth and a narrow throat, and is sounded by driving compressed air or steam through a disk placed in its throat. In this disk are twelve radial slits; back of the fixed disk is a revolving plate containing as many similar openings. The plate is rotated 2,400 times each minute, and each revolution causes the escape and interruption of twelve jets of air or steam through the openings in the disk and rotating plate. In this way 28,800 vibrations are given during each minute that the machine is operated; and, as the vibrations are taken up by the trumpet, an intense beam of sound is projected from it. The siren is operated under a pressure of seventy-two pounds of steam, and can be heard, under favorable circumstances, from twenty to thirty miles. "Its density, quality, pitch, and penetration render it dominant over such other noises after all other signal-sounds have succumbed." It is made of various sizes or classes, the number of slits in its throat-disk diminishing with its size. This instrument is now used as a fog-signal by most maritime nations, they having frankly copied from, and, in some instances, obtained it through the United States Lighthouse Establishment; and it has been recently adapted to the use of

ocean-steamers. But, to make it thoroughly useful, M. Edme Genglaire, a student of the Naval School of Medicine at Toulon, has combined with the siren what purports to be the leading idea of the topophone by fixing an invariable standard for comparison. The siren being in communication with the boiler, the current of steam can be governed by an ordinary valve. The sounds produced vary in pitch and intensity in proportion to the quantity of steam emitted, so that sounds of any given pitch can be obtained. A set of resonators completes the apparatus.

It is well known that two identical resonators vibrate together for the same sound and for that only. Starting with this principle, in two similar frames containing several resonators, the corresponding resonators will vibrate or sound only when the note corresponding to them is produced. The siren will produce these sounds causing vibrations in the resonators, and two distant ships, or a shore-station and a ship, or two land-stations, supplied with sirens of a similar model and identical frames of resonators, could most conveniently communicate. For this end each resonator should have attached to it an invariable signification, the same for all the frames.

All the naval and commercial vessels possessing sirens and a frame carrying the same number of resonators, each marked with a number having its signification, might be prepared to communicate with each other or with the shore.

This is the practical way of carrying the theory out as proposed by M. Genglaire:

In front of each resonator will be placed two metallic reeds, one rigid, the other thin and producing extended oscillations with the least effort. Each of these pieces of steel communicates with one pole or battery by means of the circuit wire. When the resonator vibrates, the thin reed oscillates, touches the other bar, and the two poles of the battery being connected, an electric bell rings, thus giving a signal, so that the call, whether from ship or shore, can be recognized, while the bell of the signaling-station, by its sounds, shows that the desired vibration or note has been produced. This account of Genglaire's siren is condensed from the account published in "Électricité."

Colladon made a series of experiments* at Lake Geneva in 1826 to determine the velocity of sound in water. He had a bell weighing about one hundred and fifty pounds suspended some five feet under water from the side of a boat, and struck by a hammer attached to the end of a lever. Stationed in another boat he listened for the bell-sounds, propagated beneath the sur-

* "Memoirs of the Institute of France," vol. v, 1838, pp. 329–399; Sir John Herschel, "Sound," sections 94, 95; "Journal of Science," vol. i, 1828, pp. 480, 481; "Edinburgh New Philosophical Journal," vol. v, 1828, pp. 91–94.

face, which were conveyed from the water by a cylindrical tube of tin some nine feet long and six inches in diameter, one end of which terminated in an orifice for insertion in the ear, and the other was spread out somewhat in the form of a spoon, its opening being closed by a flat, elliptic plate of tin, about two square feet in area. By attaching a suitable weight to the lower end of the tube it was easily retained in a vertical position with about four fifths of its length submerged, its flat plate being turned toward the boat carrying the bell. With this simple apparatus, Colladon was able to hear with perfect distinctness the blows of the hammer on the bell across the widest part of Lake Geneva, when the calculated distance between the two boats was not less than eight miles.

The sounds heard by Colladon appeared as if they had been caused "by some metallic body striking the bottom of the tube," and they were "as distinct and brief at 13,000 metres as at 100 metres from the bell." One set of observations were made during a strong wind: "The lake, which was at first calm, became violently agitated, and it was necessary to keep the boat in position by means of several anchors; yet, in spite of the noise of the waves which struck the tube, he took other observations with the same accuracy as when the air and water were still. And he states, "I am convinced that by employing a bigger bell, and improving or enlarging the hearing apparatus, easy communication could be effected under the water of a lake or of the sea up to fifteen or twenty leagues."

In February, 1883, Prof. Lucien I. Blake,* now of the University of Kansas, but then in Berlin, while investigating the experiments of Colladon and also of Sturm, as to the velocity of sound through the waters of Lake Geneva, thought of making a practical use of water as a means of communication between vessels at sea. He then devised several methods, assisted by Dr. König, of the Physical Laboratory at the Royal University, which he tried on his return to this country, and he has been experimenting in that direction from time to time since that date, as opportunity served.

His plan, in brief, was as follows: A sound-producing apparatus was to be attached to each vessel, and to be worked under the surface of the water. In times of fog or at night a code of signals would be produced by it which would be transmitted in all directions through the water, with a velocity four to five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus,

* Prof. Blake read a paper on this subject before the American Association for the Advancement of Science, at the meeting in New York, in August, 1887, from which, with his kind permission, this abstract has been made.

which would take up out of the water the signals arriving from neighboring vessels. As boys in swimming communicate the sound of the striking of stones together under water, so is it possible to send musical tones from one ship to another.

For steamships the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water, and to be heard at least from six to eight miles. From the nature of its tone it would be easily distinguishable from other sounds always more or less present under water, such as from breakers, waves, etc. With such whistles a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell-buoys were to have a second bell added under water, while lightships, lighthouses, and any headlands might also be provided with submerged bells which could be rung from the shore, when necessary. Sailing-craft, both large and small, would have bells; and, since an ordinary locomotive-bell can be heard, according to experiments, at least two miles under water, these simple means would seem to afford sufficient limits for protection for such vessels.

As to the receiving apparatus, with which each vessel was to be provided: The original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water, and connected with a receiver within the vessel. The surface of the transmitter exposed to the water, and which must receive the sound-waves, should be protected against ice, barnacles, heavy waves, etc. One design was: One or more vertical pipes in different parts of a ship were to extend from the vessel's interior through the hull, near the keel, and be open to the free admission of water at their lower ends; their upper ends were to extend within the vessel a little way above the keel, and were to be plugged, so that the water could not overflow into the vessel. These pipes would then provide columns of water always still, and would communicate directly with the water outside. Sound would then enter and pass up these pipes, and would encounter microphonic transmitters placed suitably in them. Wires from the transmitters would run to a small room secluded where convenient in the ship, away from disturbing noises, and here telephone receivers would be placed, and observers stationed here in night or fog.

For small craft, it was found that a pipe shaped much like a powder-horn, with a thin, flexible membrane stretched tightly

across its broad end, made a successful receiver. With the small end made to fit the ear, and the diaphragm end only a few inches below the water, the sound of a hand-bell has been received nearly a mile distant. Colladon and Sturm used a somewhat similar receiver, and heard a heavy bell ten miles away.

It was necessary to devise a better form of receiving apparatus. The Bell receiver and the Blake transmitter will not work under water. The first success was obtained by a form of transmitter resembling the Ader.

With this Prof. Blake transmitted and received signals between boats half a mile apart on the Taunton River in 1883. The transmitter was weighted to float at different depths, but in all positions as regards the approaching sound-waves it received equally well. Up to half a mile the signals from an ordinary dinner-bell were distinctly heard. These experiments seemed to indicate that a transmitter dependent upon a variable contact might yet be made which would work with satisfaction. This line was consequently followed up, and apparatus was devised by which signals were transmitted between boats a mile distant off Stone Bridge, near Newport, R. I., in the same summer of 1883 through a rough sea and in a dense fog. Various forms of microphonic transmitters were constructed, and experiments on Long Island Sound and on the Wabash River at Terre Haute, Ind., were conducted as opportunity permitted. One form of transmitter which worked fairly well consists merely of a diaphragm having within itself the elements of a microphone. It is placed in simple voltaic circuit with a Bell receiver. This diaphragm is made of hard carbon in granules about the size of smallest shot. A paste is made of these with rubber cement, and this in a mold and die under heat and pressure becomes a hard, thin, elastic disk. This diaphragm takes up the sound-vibrations quite well out of the water. The action is similar to that of a multiple contact transmitter. On the river, however, through a long distance these did not seem sufficiently satisfactory. This difference in action between a long and short distance led to the thought that, as the advancing front of the sound-wave is an arc, approaching in curvature nearer and nearer the tangent to its circle, a large diaphragm would receive more sonorous energy and thus probably prove more effective. This is the point to which the experiments have now been carried, and the next trials will be with a diaphragm eighteen inches square. In October, 1885, signals were transmitted and received one and a half mile on the Wabash River from a locomotive-bell around three or four windings of the river, so that the operators were out of each other's sight and the sound

could not be heard through the air, yet could be with fair distinctness through the telephone.

It is to be hoped that Prof. Blake may find opportunity to continue his experiments, as he seems to be on the verge of producing a practical and accurate instrument of value to mariners.

Methods of using the Morse code of dots and dashes, as represented by long and short sounds of a fog-whistle or other similar contrivance, have been made public. The best one I have met is that of Mr. Frank Purinton, of Providence, R. I., and it is one of the best because it is the simplest. The idea is that, when two ships meet in fog and make known their proximity to each other by their fog-signals, each shall indicate to the other the way she is steering by the length and the intermission of the sounds made by her fog-signal. The following is the code in part, the long blast being represented by the [—] dash, the short one by the [-] dot:

		Code.
North	—	One dash.
Northeast	— — —	Three dashes.
East	— —	Two dashes.
Southeast	- — —	One dot and two dashes.
South	-	One dot.
Southwest	- - -	Three dots.
West	- -	Two dots.
Northwest	— - -	One dash and two dots.

The thirty-two points of the compass are represented by variations of the collocations of dots and dashes on the chart, and with long and short sounds with intervals, in practice. These signals can be given by the ordinary steam-whistle or by automatic apparatus already invented and in use. Mr. Purinton claims that his system will, if followed, prevent collisions. The four cardinal points of the compass are so represented that opposite courses have opposite signals. One long sound means north; a short one, south. Two long sounds mean east, and two short ones mean west. Other points of the compass are indicated by the synthesis or natural combination made by adding the necessary cardinal signals for the intermediate points or courses.

Another device, which may be called the echo-maker, that of Mr. De la Torre, has been examined by a board of naval officers, of which Commander Bainbridge Hoff, United States Navy, was the head, and report was made to the Navy Department of a somewhat favorable nature. It may consist of a flaring funnel screwed on the muzzle of a rifle. It is operated by firing the rifle in the direction of the supposed obstacle, such as a rock, an iceberg, another ship, or a cliff. If the obstacle is there, the

beam of sound projected through the funnel strikes the obstacle and rebounds; and as the echo is more or less perfect in proportion as the obstacle is more or less parallel to the ship from which the gun is fired, and as it is near or remote, the position of the obstacle may thus be inferred. The board reported that De la Torre's method was firing a blank cartridge from a rifle in the presence of objects as small as a spar-buoy and as large as a fort, and catching the return sound or echo. He claims that a sharp sound projected at or nearly at an object, and only when so directed, will in every case return some of the sound sent, so that theoretically there will always be an echo, and the difference in the time between the sound sent and the echo will indicate the remoteness of the object. The board found that a return-sound could be heard from the side of a fort a half-mile off, from passing steamers a quarter-mile off if broadside-to, from bluffs and sails of vessels about the same distance, and from spar-buoys two hundred yards away.

The board further states that the sound from the different kinds of masses is different in most cases, and that the ear could be educated to detect quite a range of different objects, as the echo from a sail was different from the echo from a buoy or a bluff. If two objects were near the line of projection at different distances, an echo would be received from each. The horizontal limit of the return of sound seemed to be about two points on each side of the axis of projection.

If Mr. De la Torre should see fit to construct his instrument for hearing feeble echoes, the board indicated that it would recommend that it be fitted soon to some vessel of the North Atlantic Station, and that further and, if possible, exhaustive experiments ought to be made to practically determine the use of the echo as a means to discover obstacles to navigation. It was also stated that steam-whistles could be heard much farther than the echo; but it was said that where the obstacle could not make the sound, as in the case of an iceberg, the echo would be of the greatest use, and experiments looking to its utilization are demanded by the conditions of navigation in time of fog.

Steamers are constantly running among the islands on the coast of Maine during the summer. This is the season of thick and persistent fog. When pilots can hardly see the length of their vessels, they keep up a constant noise with their fog-signals. The open sea gives back no sound. But the near or remote vicinity of cliffs, bluffs, or even high shores, is indicated by the strength of the echo received back from them. In fact, running by echo is recognized as one of the necessities of the navigation of those waters.

This method is also used to some extent by steamers on the great rivers. And it is practiced on the Great Lakes to some extent, notably at a certain bluff jutting out into Lake Superior. Passing steamers, knowing themselves to be in the vicinity, when befogged, feel out these bluffs by sounding their fog-signals until they get back an echo; then they use the bluffs as a new point of departure.

In this connection I may say that in the summer of 1886 I experimented in making echoes while on a lighthouse steamer on Long Island Sound, and found I could get a good echo by sounding the whistle of my steamer when passing a sailing-vessel, preferably a schooner, on a parallel course. Wave-sounds striking her sails at right angles to her course, gave a good echo at five hundred yards or less, and the sound of the echo was more or less good within that distance, in proportion to the angle made by the courses of the two vessels when their courses were not parallel. When off Block Island cliffs, which overhang somewhat, I got a good echo when about a mile distant. Hence I infer that the position of suspected dangers of certain kinds can be determined by the production of echoes under specified circumstances.

Recent papers state that Mr. H. B. Cox, an electrician whose laboratory is at Fernbank, some ten miles from Cincinnati, has invented a trumpet to be used for telephoning at sea, on which he has been at work for some months. The invention is the outgrowth of his discovery of the great distance an echoed or reverberated sound will carry, and the discovery that speaking-trumpets, if made to give the same fundamental note, would vibrate and produce the phenomenon known in acoustics as "sympathy."

With this trumpet conversation in an ordinary tone of voice was carried on between parties four and a quarter miles apart. People a mile away, conversing in an ordinary tone, could be distinctly heard, and in two instances they were told the nature of their conversation, and admitted that such had taken place. The whistle of a train was traced beyond Fernbank to Lawrenceburg, Ind. It was found that the instrument has a well-defined range of twenty-six miles; that is, a loud sound like a locomotive-whistle, or the rumbling of a train, can be distinctly heard at a distance of thirteen miles in every direction. Conversation was readily carried on between two gentlemen on high hills on opposite sides of the Ohio River distant about four and a half miles apart. Tests made on the water, of various kinds, showed that the trumpet was even more available than on land.

It is generally understood that Mr. Edison, who has invented so many good things, is now at work, and has made promising

progress on the production of what may be called a water-telephone, by which he proposes to enable ships within hearing distance to communicate without wires, but still by electricity, sent and received through the water. He is said to have signaled through a mile of the Caloosahatchie River, in Florida, during his experiments made last winter.

The object of this paper is to call attention to the practical impossibility of the mariner determining, by his unassisted ears, in a fog or in darkness, the position of another ship from the noise she makes, and the necessity that he should use some of the appliances named, or better ones as they appear, to assist his ears, and thus to prevent the collisions which are now so frequent and so disastrous. The Celtic and Britannic steamers would not have run into each other had such appliances been used; nor would the steamer the City of Brussels have been run down in the English Channel by the steamer Kirby Hall had they been thus supplied, to say nothing of the steamer Oregon recently sunk off Fire Island, and other like cases within easy recollection. These vessels carried no such appliances.

It is desirable that public opinion should be brought to bear on this subject with such force that ships shall be *required* to carry some appliance, so that an error of five points in fixing a ship's position will no longer be possible, or, if possible, will be held to be criminal negligence.

It is also desirable that public opinion should be brought to bear on this subject with so much force that ships will be required to carry and use proper appliances for ascertaining the position and course of ships within ear-shot, as they are now required to carry lights for a like purpose.

And why should not the Federal Government take some steps in this direction, that the dread all now feel of collision at sea, in the fog or the darkness, may in some measure be eliminated?

Since the foregoing was in the hands of the editors, Senator Frye introduced into the Senate Bill No. 1851, "to provide for an international conference for securing greater safety for life and property at sea." The President, under this bill, is to invite each maritime nation to send delegates to a maritime conference, to meet at Washington in October next, and to appoint five delegates to represent the United States.

One of the duties prescribed for this conference is "to adopt a uniform system of marine signals or other means of plainly indicating the direction in which vessels are moving in fog, mist, falling snow, and thick weather, and at night."

This bill was referred to the Committee on Foreign Relations,

whence it was reported back on February 15th with certain helpful amendments. On February 23d it was taken up, when Senator Frye said: "That is a public bill of very great importance. . . . It is a bill recommended by the President and Secretary of State, and indorsed by nearly all the boards of trade, chambers of commerce, and maritime associations." The bill was then passed and sent to the House of Representatives, when it was referred to its Committee on Foreign Affairs.

PRIMITIVE WORSHIP OF ATMOSPHERIC PHENOMENA.

By the Count GOBLET D'ALVIELLA.

ATMOSPHERICAL manifestations, or the aggregate of the phenomena whose theatre is the atmosphere, present a mysterious appearance to primitive man, which, whether it seem beneficent or fearful, is always of a nature vividly to impress the imagination. Hence man very early regarded these phenomena as individualities endowed with body and soul, or as superhuman personalities, which he was afterward led to make an object of worship. This is easily shown to be the fact in the case of the dawn and twilight, wind, rain, clouds, whirlwinds, and waterspouts, lightning and thunder, echoes, the rainbow, the aurora borealis, the mirage, etc. Rain has at times been represented as honey or seed which fell from the sky to fertilize the earth, as in the myth of Danae; the peoples of India have personified the waters of the sky as the milkings of cows; a step further, and we have the goddess of rain. The Khonds of central India fabled that these waters were poured upon the earth through a sieve by a nymph who was called Pizou Pennou.

The clouds have been personified under the form of serpents, dragons, birds, or wolves; in the mythology of peoples who suffer from drought these personifications take the shape of thieves and receivers, which carry off the waters and keep them captive. Such assimilations may appear strange at first sight; it is hard for us to imagine that man could have compared the clouds to such objects. The philological school supposes that man began by giving the clouds the names of animals whose forms they most frequently affected; but at last these appellations lost their character, which was in its origin simply metaphorical, and thus arose the idea of assimilating the clouds to the animals whose names they bore. This theory is not without some foundation, but it is not in general indispensable to look to changes in language. Man, especially childish, primitive man, is

naturally disposed to substitute a relation of identity for a simple relation of analogy. On this subject M. de Gubernatis relates, in his "Zoologie mythologique," a personal recollection of the most significant character. When he was four years old, his brother having called his attention to a curious-looking group of clouds by saying, "See that wolf chasing the sheep!" he was so fully convinced that the cloud was really a hungry wolf running over the mountains, that he ran into the house, for fear that the wolf, not finding sheep, would take him.

Dawn and twilight are only rarely made divinities among untutored peoples. But they are personified in a curious Esthonian myth among the Finns. It is related in this story that the sun is a torch lit up every morning by *Koi*, the dawn, and put out every evening by *Œmmerik*, the twilight. Their father, *Ukko*, the sky, desiring to unite them, they consented to come together for a few days every year at the time of the summer solstice, at which time there is in Finland no night between the twilight and the dawn. On these days, the legend continues, Œmmerik passed the torch directly to his affianced, and she blew it alive with her breath before it had time to go out.

While both the twilight and the dawn were deified among the Aryans, the more special importance was given to Aurora, the dawn. She it was among the Greeks who daily with her rosy fingers opened the eastern gates, and brought back the light, which was equivalent to a new creation and the dispersion of the demons of night. In the Greek mythology, Aurora precedes the chariot of the sun; and on an Apuleian cup the decorator has depicted an ingenious allegory, showing Selene (the moon) mounted upon a chariot, and driving away, with her face veiled; Aurora preceding the solar team as it courses through the air; while around the chariot infants, representing the stars, are disappearing in the depths of the sky. This representation is very like a description that may be found in the Vedas, where it is sung: "The stars fly like thieves, in company with the night, before the radiance of the dawn, which, like a herald, precedes the course of the sun." "Hail, ruddy Ushas," says another hymn, "golden goddess, borne on thy bright chariot! Thou advancest like a solitary virgin, discovering to our admiring eyes all thy hidden graces, or like a spouse unveiling to her lord beauties which appear to him every morning more fresh and brilliant! Although thou countest years upon years, thou art always young. Thou art the breath and the life of all that lives and breathes, wakening every day myriads of prostrate sleepers, causing birds to fly out of their nests, and guiding the busy steps of mortals in the occupations which they pursue in the search for riches, pleasure, or fame." The Vedic *Ushas*, like the *Eos*

sung by the poets of Greece, are deities conceived as under a human form, but still imperfectly isolated from the phenomena which they personify. If, as Max Müller thinks, *Aditi*, of the Vedic mythology, is likewise a name for the dawn, we see clearly that the worship is addressed at first to the personified phenomenon, or to the spirit of the dawn conceived as inseparable from the phenomenon itself. A passage in the Vedas calls the dawn the face of Aditi. Moreover, if Pallas Athene was also the dawn with the Greeks, does not the fact that she was born issuing from the brain of Zeus—that is, of the sky—indicate that the worship was originally addressed to the personification, even before it was carried over to the goddess regent, of the phenomenon?

Wind and thunder have also been personified, or made objects in which was seen the action of a personal being having a sensible form appropriate to its office. To the savage the wind is produced by a blowing being, thunder by a thundering being. The Lapps imagine a living existence, who soars in the air, carefully listening to the words of men, and always ready to strike down any one whom he condemns. The Bushmen believe that the wind is a person. One of them met him one day in the country of the Boers, and threw a stone at him, when the wind fled to the mountain. In the "Iliad" Homer represents the winds as seated at the table of Zephyr, when Iris solicits their intervention to kindle the flames on the funeral pyre of Patroclus. In our own times, even in Europe, according to Mr. Tylor, the Carinthian peasant places on a tree in front of his house various foods to appease the hunger of the wind. In the Palatinate, when a storm is raging furiously, the peasant throws a handful of meal in the direction opposite to the wind, and calls out: "Stop, wind, here is food for your child; go away!" In South America, the Payaguas, when the wind shakes their huts, rush against the storm, waving fire-brands; while other tribes, under like circumstances, offer it tobacco. The forms given to the personification of the wind are extremely various. In Central America, it is often a bird; on the Congo, a horse; the American Indians make it a hare; the Botocudos represent it by a dog with clipped ears; the Germans gave it the figure of coursing dogs; and the Greeks represented it by cherubim's heads with swelled cheeks.

The idea of a distinction between the manifestations of the wind and thunder, and the being which produces or controls them, seems to have been gradually developed. The Dakotas attribute thunder to a great bird and its progeny. The male produces the isolated claps by the beating of its wings, and the reverberations are due to the beatings of the wings of the younger ones. To the Navajos, the winds are produced by four swans,

which, placed at the four points of the compass, beat their wings in alternation. The Assiniboins have a supreme deity, the manitou-bird, who lives in the upper skies; his eyes shoot out lightning, the beatings of his wings produce thunder, and his beak causes the falling rain. Belief in a thunder-bird is also found among the Brazilians, the Hervey-Islanders, the Caffres, and the Karens of Burmah. Thor, who strikes men with his hammer, is well known. In the Vedas, Parjana is depicted as the god with resounding song who beats down the forests and makes the earth tremble; who frightens the innocent, while he strikes down the guilty; who diffuses life, and at whose approach vegetation springs up again. The Yorubas of western Africa fancy that thunder is produced by the god Zaconta throwing stones. The Slavs attribute the noise of thunder to the rolling of Elijah's chariot in the skies. The legend of the celestial father playing at ninepins with the porter of paradise is of common lore. The classical Æolus is matched by a similar conception among the Iroquois and the Polynesians, by whom the winds are supposed to be controlled by a divinity who holds them shut up in a cavern, whence he lets them out at his will. A legend current in New Zealand has it that each wind is assigned to its cavern, where the god Maui lets them out, or shuts them up by rolling a great stone in front of the mouth. But the west wind is excepted from this rule; the god can not reach it or find its cave, and it therefore blows during the largest part of the year. The red Indians all believed in the spirit of the wind as the supreme god, or the Great Spirit. In the Vedas, we find in turn *Vâya,* the breath, *Vâta,* the breather, and *Roudra,* the howler. The Esthonians direct their prayers to the mother of the winds, and exclaim on the approach of a tempest: "The mother of the winds is groaning; who knows how many other mothers are going to groan in their turn?" Sometimes the god of the wind becomes a mythological personage so distinct that we find it hard to discover his natural character; and it is still under discussion whether Hermes or Mercury personified the wind or the twilight.

Whirlwinds or water-spouts have been personified under the form of giants, of gigantic serpents, and of sea-dragons, as they said in the middle ages. "The sea was troubled before them," relates a character in the "Thousand and One Nights"; "from its bosom rose a black column toward the sky; I looked, and it was a Jinn of gigantic stature." This belief is common with all the Mussulman peoples. The columns of sand in the desert pass, in the eyes of the Arabs, for wicked genii. In China they believe that these formations are dragons; the Zulus make great serpents of them.

It is hard to conceive in temperate latitudes of the splendor of

the light-pictures formed by the aurora borealis of the polar countries; and it is not surprising that the Greenlanders see in them a dance of spirits. Even in countries farther south, where the intensity of the phenomenon is greatly reduced, the aurora borealis has given rise to the most fantastic legends. An English writer of the sixteenth century represented the phenomenon as an "aggregation of brilliant arches whence issue fortified cities, swords, and warriors in order of battle; then jets of radiations in every direction, clouds and combats, in which the victors pursue the vanquished, while others fly around in a surprising fashion."

Echo passes nearly everywhere as the voice of a superhuman power. Lander relates that on the Niger his boatmen offered libations to an echo. When the traveler asked them the reason for it, they answered: "Do you not hear the fetich?" It is also conceivable that the existence of a voice should cause a belief in some one who speaks. The fact that this mysterious voice limits itself to repeating the words that are sent to it, has induced the fancy that the spirit has particular reasons for acting in this way, and it is in support of such reasons that myths, like that of Echo and others, have been given form.

The rainbow is one of the atmospheric phenomena that have been most generally personified. Peoples of almost every part of the world have made of it a living and terrible monster whose most venial offense is that of drinking up the waters of springs and ponds. This belief is found among the Burmese, Zulus, Indians of Washington Territory, ancient Mexicans, and Finns, and exists among the popular fancies of the Slavs and Germans, and some of the French populations. The Zulus and the Karens of Burmah imagine that the rainbow spreads sickness and death. The Karens, when they see one, say to their children: "The rainbow has come down to drink; do not play, for fear that harm may come to you!" Very singularly, too, the street boys in Volhynia run away, crying, "Run, it will drink you up!" In Dahomey, the rainbow is regarded as a heavenly serpent, *Danh*, which insures happiness. The modern Greeks hold it to be a beneficent but just and severe hero; they say that any one who jumps over a rainbow will change sex at once; but this saying, which is also current in Alsace, is only a picturesque way of indicating the impossibility of transforming a man into a woman, or a woman into a man. The Delians offered cakes to the rainbow, and the Peruvians put its image on the walls of their temples. The Caribs considered its appearance on the sea a favorable presage; but on the earth its influence was pernicious, and they hid from its view. It was personified by a viper.

A considerable number of peoples give the personified a coex-

istence with the depersonified rainbow, or reduce it to the state of a thing, but even then invest it with a marvelous function. Some have made of it a celestial bow, which they place in the hands of a god; with the Lapps, it was the bow of the god of the thunder, by means of which he shot off his arrows of fire; with the Australians, it was the *phallus* of the god of the sky, which grazed the earth as it passed; with the Samoyeds and the Kamtchatdales, it was the hem of the clothing of Billoukai, the god of the thundering sky; and among the classic ancients, it was the scarf of Iris, the fair messenger of the gods. In Polynesia and with the Germans, Hindoos, Persians, and Arabs, the rainbow was regarded as a bridge uniting the abode of the gods with that of men; the road over which souls traveled; with the Jews, it symbolized the alliance of God and man; with the Greeks and Romans, it was a sign of war or of storms.—*Translated for the Popular Science Monthly from Ciel et Terre.*

THE FUTURE OF THE AMERICAN INDIAN.

By THOMAS J. MAYS, M. D.

IT is quite evident that the history of the American people would be very different from what it is, or from what it will be, had they not on the very threshold of their existence encountered a race of warlike savages, and had not their stability been still further threatened by a later introduction of slave labor from Africa. Had the immigration to this country been strictly confined to members of the Caucasian family, there would undoubtedly exist a mutual feeling of physiological and social harmony—since they all stand on a plane of civilization which is common to the American; but so soon as the latter came in contact with races which were aliens and strangers to the Anglo-Saxon blood, and which were several thousand years behind it in point of civilization, an inevitable clashing of interests began which prevails to this day, and which will continue until the race differences are eradicated. No one, however, who has given serious attention to the political and social questions of this country can fail, even at this day, to perceive that, in spite of statutes and of prejudices, there are influences at work which tend to fuse our heterogeneous population into one common whole. Whether these influences are active so far as the colored or negro race is concerned is not very readily determined, since accurate statistics bearing on this point are wanting; yet indirect evidence, inconclusive as it may be, strongly favors such a view. The remarks in this paper will, therefore,

be confined to an inquiry as to how far these influences obtain among our North American Indians, since we possess more reliable data concerning this than that of the negro race.

Quite recently I had the opportunity of making an investigation into the type of respiration as it exists in the Indian female, and I then unexpectedly found that a large proportion of the Indian girls which were examined had white blood coursing through their veins, and that this not only modified the color of their skin, but also had a marked influence on their mode of breathing. It is well known that, as far back as 1774, Boerhaave observed a different type of respiration in civilized man and woman—the former breathing principally with the diaphragm or abdomen, which is called the abdominal type; while the latter breathes principally with the upper portion of the chest, which is called the costal type. This investigation was carried on in the Lincoln Institution of Philadelphia—a school for Indian girls—and was undertaken with a view to ascertain whether the Indian female, who is not accustomed to the wearing of corsets and tight clothing around the abdomen, has the same type of respiration as that which obtains among our civilized females, and in all I examined the chest-movements of eighty-two Indian girls by means of a pneumograph devised by me somewhat after that of Paul Bert. In each case I took an abdominal and a costal tracing. Of the eighty-two girls which were examined, and whose ages ranged between ten and twenty years, there were only thirty-three full-blooded Indians; five were one fourth, thirty-five were one half, and two were three-fourths white. Seventy-five girls showed a decided abdominal type of breathing, three a costal type, and in three both were about even. Those who showed the costal type, or a divergence from the abdominal type of breathing, came from the more civilized tribes, like the Mohawks, Chippewas, etc., and were either one half or three fourths white, while in no single instance did a full-blooded Indian girl possess this type of breathing. This is significant in showing that, so far as the Indian is concerned, the abdominal type is the original type of respiration in both male and female, and that the costal type in the civilized female is acquired through the constricting influence of dress around the abdomen. That which is of still greater importance, however, is the fact that only those girls who were either one half or three fourths white, and who were hence under the greater domination of the inherited characteristics of civilized blood, possessed the costal or an approach to the costal type of respiration.

An examination of the pupils of the Lincoln Institution, therefore, not only shows that a rapid amalgamation is taking place between the white and the Indian races, but that the latter is

also acquiring some of the physiological peculiarities of the former. This blending of white and Indian blood is still further confirmed by the varied composition of the Indian male pupils in the Educational Home for Indian Boys in Philadelphia, as is shown by the report of this institution for 1886. From this source we learn that among the one hundred and seven boys there were only thirty-eight full-blooded Indians; of the remainder one was three fourths, sixty-one one half, and seven were one fourth white. Similar testimony comes from the reports of the Commissioner of Indian Affairs. These reports not only show the existence of a very large proportion of mixed bloods among the 250,000 Indian population of this country, but also a marked increase of the former during the years 1885 and 1886—the only years in which a record of the total number of mixed bloods is supplied. Thus, in the year 1885 there were 18,412 and in 1886 there were 20,567 mixed bloods, an increase of more than 2,000 during one year. The pure Indian population for the former year was 259,244, and for the later 247,761, a decrease of over 11,000 during the same time.

It is furthermore evident from these reports that the number of mixed bloods in each agency is very naturally determined by the length of time which the Indians have been exposed to contact with the white race, as is shown by the following table, where are given the names of various agencies, the Indian population in each one, the number of mixed bloods in each, the proportion of mixed bloods to Indian population, and the dates of treaty:

No.	NAME OF AGENCIES.	Indian population in each agency in 1886.	Number of mixed bloods in each agency in 1886.	Proportion of mixed bloods to Indian population of each agency in 1886.	Date of treaty—showing the length of contact between the white and Indian.
1	New York, N. Y.....	4,961	2,890	1 to 2	1797
2	North Carolina, N. C.....	3,000	1,000	1 to 3	1833
3	Cherokee, Ind. Ter.....	22,000	7,633	1 to 3	1833
4	Osage, Ind. Ter.....	905	456	1 to 2	1839
5	Green Bay, Wis.....	2,000	1,309	1 to 1½	1848
6	White Earth, Minn.....	5,885	1,013	1 to 5	1855
7	Mackinac, Mich.....	9,572	5,700	1 to 1½	1855
8	Colorado River, Ariz.....	2,527	2	1 to 1,263	1865
9	Shoshone, Wyom. Ter....	1,800	16	1 to 112	1868
10	Cheyenne River, Dak. Ter.	2,965	158	1 to 18	1868
11	Pine Ridge, Dak.....	4,973	445	1 to 11	1868
12	Fort Hall, Idaho	1,444	30	1 to 48	1868
13	Colville, Wash. Ter.....	2,350	35	1 to 67	1872
14	Sac and Fox, Iowa	380	None.	.....	1882
15	Pima, Maricopa, and Papago, Ariz.....	12,050	6	1 to 2,008	1883

NOTE.—It may be stated that the dates of treaties may not be absolutely correct.—AUTHOR.

After making due allowance for the remote location of some of the oldest agencies, this table shows very conclusively that the mixed bloods are most numerous in those tribes that have been longest in contact with the white race. This is illustrated by the first seven agencies. Of course this is quite natural, but it demonstrates still further that in the older agencies, like those of New York, Green Bay, and Mackinac, there are nearly as many mixed as pure bloods. This is indeed surprising, for, if we consider the fact of the increase of the mixed bloods in connection with the fact that the pure Indian is probably decreasing in numbers, it is quite evident that the day will not be far distant when the remnant of the once proud American Indian will be incorporated into the white race.

This, then, so far as the American Indian is concerned, is the natural drift of things as best it can be divined at the present time, and that which becomes of absorbing interest to us is the question of the stability of this new product. Will it be better able to resist disease and death than the original Indian stock, or will it, like the latter, tend to disappear because there is a want of harmony between itself and its surroundings? While this question can not be determined positively on account of a lack of reliable statistics, there are reasons for believing that the offspring of such an alliance is stronger and more vigorous than the pure Indian. This is in accord with what might have been expected on *a priori* grounds alone, for the mixture of a lower with a higher blood will certainly improve the nature of the former, while it will just as certainly impair that of the latter.

The experience of the teachers of the Lincoln Institution confirms the views here expressed, that the mixed Indian is more exempt from pulmonary disease than the pure Indian; and, further, that if the former are attacked by disease, they offer greater constitutional resistance to it than the latter. This view is also confirmed by the large experience of Captain R. H. Pratt, Superintendent of the Carlisle Indian School, who says in his last report:* "Our experience is, that the mixed bloods resist disease and death from pulmonary troubles better than the full-bloods; and our best health conditions are found among those we send out into families—due, I think, very largely to the regular occupation and varied diet."

Similar views have been expressed by others † who have resided among the mixed or half-breed races in the northwestern part of Canada. These people are said to be strong and hearty, long-lived, and not subject to disease, so long as they remain in

* See Report of Indian Commissioner for 1886, p. 22.

† See "Mixed or Half-Breed Races of Northwestern Canada," by Dr. A. P. Reid, "Journal of the Anthropological Institute," 1874, vol. iv, p. 45.

their native climate. They regard themselves as the equal of the whites, and look in a patronizing way on the Indian. Their families are usually very large, and the female sex is said to be very handsome.

Quite recently I had occasion to investigate the question whether *pulmonary consumption tends to exterminate the American Indian?** and I then found that nearly all those Indian agencies which show the lowest consumption rate are precisely those which are shown in the table of this paper to contain the largest number of mixed bloods. Of course, it is just possible that the presence and the absence of pulmonary consumption in certain tribes is purely a coincidence; yet I think, from what has been said concerning the improved physical condition of the mixed Indian, it is quite evident that the greater immunity of these tribes from consumption is due to the fact that they comprise a large element which has a superior power of warding off disease.

These facts and inductions obviously show that Nature steps in and adds more toward a solution of the difficulties of the Indian problem than statesmanship has ever accomplished. Such a process, although at the beginning it acts prejudicially to the interests of the white race, will in the end operate to the advantage of both races. There can be no doubt that the harmony of feeling which it establishes, and the permanency of common interests which it insures, counterbalance all the evils which it ever inflicted. Moreover, these developments also confirm the wisdom of the course of our Government, and that of our philanthropic people who have undertaken to second these efforts of Nature, by educating and training the growing generation of Indians in the ways of civilization and of Christianity.

DARWINISM AND THE CHRISTIAN FAITH.

I.

THE publication of the "Life and Letters of Charles Darwin," a review of which has already appeared in the pages of the "Guardian," seems a fitting opportunity for attempting to face the question how far Darwinism affects Christian faith, and what are the points of traditional interpretation or apology which are modified by it. Christian theology has no fear of scientific discoveries. It claims all truth as belonging of right to Him who is the Truth. But Christian theologians are but slowly learning that panic fear of new theories is as unreason-

* See "New York Medical Journal," for May 7, 1887.

able as the attempt to base the eternal truth of religion on what may eventually prove to be a transient phase of scientific belief.

With regard to evolution, however, we are dealing with what may fairly claim to be an established doctrine. Certainly it is not too much to say that in the scientific world it has won its way to security, and has brought over to its side the vast majority of those who have a right to give an opinion on the scientific question. In saying this, however, we do not mean that evolution is stereotyped in the form in which Darwin gave it to the world. No one would more indignantly resent such a possibility than Darwin himself. And it is remarkable that the year which told us the story of Darwin's work and life, found us face to face with two attempts to carry out the doctrine of evolution in different, and as it seems, mutually inconsistent lines. In the July number of the "Journal of the Linnæan Society," 1886, Mr. Romanes propounded a theory—perhaps we should more properly say suggested for consideration a theory—to which he gave the name of physiological selection. Last year, thanks to two excellent articles in "Nature," by Prof. Moseley, and a paper at the British Association on "Polar Globules," we were introduced to Prof. Weismann's "germ-plasma" doctrine.

What is commonly known as Darwinism includes in it two elements which are by no means necessarily connected—the one the Lamarckian theory of descent, the other the more strictly Darwinian theory of natural selection. We had got so accustomed to being told that the experience of one generation became the instinct of the next, and that the transmission of acquired habits was one of the most important as well as the most obvious factors in the variation in species, that it is somewhat startling to be told now that there is no verified case of the transmission of acquired characters, and that the Lamarckian doctrine of descent was never essential to Darwinism, though it existed as a survival in it. Yet this, in short, is Prof. Weismann's view, and it was received with general favor at the Manchester meeting of the British Association. It would seem to those who speak without special knowledge that the two views advocated respectively by Mr. Romanes and Prof. Weismann are mutually incompatible, and that the latter view if adopted would be fatal to some of the most cherished theories of Herbert Spencer. According to Mr. Romanes, "natural selection is not a theory of the origin of species." * According to Prof. Weismann, natural selection is the main cause of such variation. Mr. Romanes talks of the "swamping effects of intercrossing," while Prof. Weismann sees in every case of sexual reproduction a multiplication of the possibilities of adaptation to an unfavorable

* "Journal," p. 398.

environment. Finally, Mr. Romanes postulates a highly variable reproductive system of which no explanation is given, and by this he would explain the sterility of species *inter se;* Prof. Weismann carries us back to the Protophyta and Protozoa, where strictly speaking there is no reproduction, and to the direct action of environment upon these, from which, in the Metaphyta and Metazoa, by sexual reproduction we get "spontaneous" tendencies multipled in geometrical ratio. These "spontaneous," or, as we prefer to call them, "inherent" tendencies or characters, are transmissible; acquired characters are not. We trust we have not misrepresented these views. We notice them not in the least with a view to deciding between them, though there is little doubt which way the balance of scientific authority at present inclines; still less with the wish to make capital out of their disagreement, but in order to emphasize the fact that, while Darwinism is generally accepted in the scientific world, there is much which as yet is unsettled; in other words, that, while every competent man of science now believes in the origin of species by progressive variations, we can not be too much on our guard against stereotyping any theory as to the proximate causes. It is nearly as true now as when Darwin wrote it in 1878 that, though "there is almost complete unanimity among biologists about evolution, . . . there is still considerable difference as to the means, such as how far natural selection has acted, and how far external conditions, or whether there exists some mysterious innate tendency to perfectibility." *

In the present and a future article we propose to deal with the doctrine so far as it is generally accepted by scientific men, and, without attempting to discuss the evidence on which the doctrine rests, to answer the following question: Given a Churchman who accepts the dogmatic position of the English Church on the one hand, and who, so far as he is able to understand it, believes the doctrine of evolution to be the truest solution yet discovered by science of the facts open to its observation, what reconstruction of traditionally accepted views and arguments is necessary and possible? How is he to relate the new truth with the old?

In so stating the problem we put out of court three classes of persons: (*a*) those who, intrenched in the fortress of religious certainty, are content to leave intellectual problems alone and ignore the movement of scientific thought around them; (*b*) those who are so "immersed in matter" that the religious side of their nature has become atrophied by disuse; and (*c*) those who possess the wonderful power of keeping their intellectual and religious life "sundered as with an axe," who, if they were chal-

* "Life and Letters," ii, p. 412 (American edition).

lenged to give a theory of human nature, would have to represent it as if it were a modern ironclad built in water-tight compartments.

In contrast, then, with these three classes we take the case of an ordinary Churchman with perhaps something more than the ordinary intellectual and speculative interests, and certainly with more knowledge of what is *de fide* and what is not, than most Churchmen possess; a man who rejects the modern panacea of indefiniteness, and refuses, even though he might claim the precedent of a Homeric goddess, to throw over the battle-field "a nimbus of golden mist" to cover the retreat or defeat of a favorite hero. Such a man, accepting Darwinism, will expect not only that a reconstruction, or at least a resetting, of his beliefs will be necessary, but also that real effort, moral and intellectual, will be required for the work. No new truth can, without effort, be related with the truth already appropriated by the mind, and the wider and more far-reaching the truth the greater the effort which will be required. This is why the in-rush of new truth means unsettlement, and perhaps, in the reconstruction, a renouncing of something which has been associated with spiritual truth, though not of the essence of the truth itself.

Dr. Asa Gray, the American botanist, writing to Mr. Darwin about the "Origin of Species,"* says: "It is refreshing to find a person with a new theory who frankly confesses that he finds difficulties, insurmountable at least for the present. I know some people who never have any difficulties to speak of."

In attempting to answer the question we have proposed to ourselves, we do not profess to be of the number of those happy or unhappy people who have "no difficulties." We can, at most, hope to remove some difficulties which are more apparent than real, and, with regard to others, to suggest hints which have helped us, in the hope that they may be of use to others:

1. The first difficulty which will probably occur to any one is this: Darwinism offers an explanation of the origin of species. How is this reconcilable with the first article of the creed, the first sentence of the Bible? A man of average intelligence will not hesitate long here, unless the issue has been confused for him by the one-sided statements of ignorant partisans. For science neither says, nor professes to say, anything about the ultimate origin of things. Mr. Darwin says: "I believe that all animals are descended from at most only four or five progenitors, and plants from an equal or less number.† . . . All the organic beings which have ever lived on this earth may be descended from some one primordial form."‡ And he adds, "There is grandeur in this view of life, with its several powers, having

* "Life and Letters," ii, p. 66. † "Origin of Species," p. 424. ‡ Ibid., p. 425.

been originally breathed by the Creator into a few forms or into one." *

Haeckel and some other evolutionists would go further. They would believe, though all the experimental evidence is at present against such a view, that life ultimately arose from inorganic matter. But even here there is no suggestion as to the ultimate origin of that matter, out of which all the world, as we know it, came. In the language of technical theology, evolution deals with secondary (i. e., derivative), but does not touch primary, creation. In Haeckel's less exact way of stating the distinction it deals with "creation of form," but knows nothing about "creation of matter." Of the latter, i. e., original creation, Haeckel says: "The process, if indeed it ever took place, is completely beyond human comprehension; and can, therefore, never become a subject of scientific inquiry." †

Prof. Tyndall, speaking of the "evolution hypothesis," says: "It does not solve—it does not profess to solve—the ultimate mystery of this universe. It leaves, in fact, that mystery untouched." Prof. Clifford again says: "Of the beginning of the universe we know nothing at all." Herbert Spencer, indeed, rejects primary creation, but not on the ground that evolution offers an alternative for it, but because it is "literally unthinkable"; and Prof. Huxley, on the ground that, as science knows nothing about it, nothing can be known. Q. E. D. But Mr. Darwin tells us that "the theory of evolution is quite compatible with the belief in a God"; ‡ that when he was collecting facts for the "Origin" his "belief in what is called a personal God was as firm as that of Dr. Pusey himself"; #; while even at the time when the "Origin of Species" was published, he deserved to be called a theist." ‖ Later on he says: "The mystery of the beginning of all things is insoluble by us; and I for one must be content to remain an agnostic." Yet, three years later (1879), in a private letter, he writes, "In my most extreme fluctuations I have never been an atheist in the sense of denying the existence of a God." ^ These quotations, which of course might easily be multiplied, are enough to show that evolution neither is, nor pretends to be, an alternative theory to original creation. An evolutionist, therefore, who denies the fact of creation, goes as far beyond the evidence which science offers as if he had asserted his belief in "the Maker of heaven and earth."

2. But then evolution does clearly offer us a theory as to how the world came to be what it now is, and in this we are told it contradicts the Bible and the unvarying faith of Christendom. We have here a clear issue raised between two alternative the-

* "Origin of Species," p. 429. † "History of Creation," i, p. 8, English translation.
‡ "Life and Letters," i, p. 277. # Ibid., ii, p. 412. ‖ Ibid., i, p. 282. ^ Ibid., i, p. 274.

ories—the one the theory of Darwin, the other the theory of "special creation," and they are mutually destructive. If the theory of "special creation" is true, Darwinism is false; if Darwinism is true, "special creation" is false. And this issue is plainly accepted by both parties. Thus Mr. Darwin says, "I have at least done good service in overthrowing the dogma of separate creations"; and Haeckel, in the preface to his "Evolution of Man," boasts that "when, in 1873, the grave closed over Louis Agassiz, the last great upholder of the constancy of species and of miraculous creation, the dogma of the constancy of species came to an end, and the contrary assumption—the assertion that all the various species descended from common ancestral forms—now no longer encounters serious difficulty." Darwin was fully aware of the opposition his theory would have to encounter. And he feared the men of science as much as the theologians. "Authors," he says, "of the highest eminence seem to be fully satisfied that each species has been independently created." When he first hinted at the theory to Joseph Hooker in 1843, he says, "I am almost convinced that species are not (it is like confessing a murder) immutable,"* and his utmost hope is that he may be able "to show, even to sound naturalists, that there are two sides to the question of the immutability of species,"† and that "allied species are co-descendants from common stocks."‡ Whether true or not scientifically, this does not sound like a dangerous heresy, and yet the outcry raised from the side of religion was as great as that raised by contemporary science. Even now religious people are surprised to be told that it is a purely scientific question, to be decided solely on scientific evidence, and to be dealt with effectively only by scientific men. It is not the question whether species were created by God or came into existence independently of him, or (as Huckleberry Finn puts it) "whether they were made or whether they just *happened.*" For science repudiates chance—except as a name for unexplained causation—as earnestly as religion does. It is a question between two views as to secondary creation, or, more strictly, between a theory and the denial of the possibility of a theory as to the method of this creation. The question is this: Were species directly created at the first, or by intermediate laws, as individuals are?# Were they independently created, or descended from other species?‖ "To say that species were created so and so," says Mr. Darwin, "is no scientific explanation, only a reverent way of saying it is so and so."△ "Special creation" is here on the agnostic side, while evolution at least attempts to bring God's action in the past in line with his action

* "Life and Letters," i, p. 384. † Ibid., i, p. 389. ‡ Ibid., i, p. 393.
# Ibid., i, p. 394. ‖ Ibid., i, p. 437. △ Ibid., i, p. 437.

in the present; his creation of species with his creation of individuals. According to special creation, forms of life are produced by the will of God; having, indeed, the minutest analogies to one another, and yet having no relation to one another. According to evolution, species are not merely created by God, but created by him according to a method which relates each species with the rest, and explains their analogies, like family likenesses, by a common ancestry.

We have purposely stated this in the language of religion, as Mr. Darwin not unfrequently does. But it is a purely scientific question; and Mr. Darwin, we think rightly, afterward expressed his regret at having used "the Pentateuchal term of creation,"* because of creation, in its strict sense, as ultimate origin, science knows and can know nothing. The question thus becomes one between those who hold and those who deny the immutability of species. The last are commonly spoken of as "Transmutationists"; the former might have been nicknamed "Immutables," but unfortunately they were too often called "Creationists," and the scientific issue was obscured for both parties by theological *animus*. Hence a belief in God as Creator came to be associated with the denial of transmutation, and a theory of transmutation was supposed to imply a rejection of the Christian creed.

It is really time that the doctrine of "special creations," which some theologians cling to so tenaciously, was held up to the light. Where did it come from? Who invented it? Everybody will at once say, "The schoolmen," because nobody reads the schoolmen, and people have a vague notion that "genus" and "species" are as much a monopoly of the schoolmen as are "entity" and "quiddity." But the schoolmen were transmutationists! They didn't believe in fixity of species any more than they believed in the uniformity of nature. For them the transmutation of plants was as possible as the transmutation of metals. The "reign of law," which is a commonplace with us, was unknown even in the days of Bacon. It is hardly credible to us that Lord Bacon, the father of modern science, as he is called, though he was only a schoolman touched with empiricism, believed not only that one species might pass into another, but that it was a matter of chance what the transmutation would be. Sometimes the mediæval notion of vivification from putrefaction is appealed to, as where he explains the reason why oak-boughs put into the earth send forth wild vines, "which, if it be true (no doubt)," he says,† "it is not the oak that turneth into a vine, but the oak bough, putrefying, qualifyeth the earth to put forth a vine of itself." Sometimes he suggests a reason which implies a kind of law, as when he thinks that the stump of a

* "Life and Letters," ii, p. 203. † "Natural History," Cent. vi, p. 522.

beech-tree when cut down will "put forth birch," because it is "a tree of a smaller kind which needeth less nourishment." * Elsewhere he suggests the experiment of polling a willow to see what it will turn into, he himself having seen one which had a bracken fern growing out of it! And he takes it as probable, though it is *inter magnalia naturæ*, that "whatever creature having life is generated without seed, that creature will change out of one species into another." Bacon looks upon the seed as a restraining power, limiting a variation which, in spontaneous generations, is practically infinite, "for it is the seed, and the nature of it, which locketh and boundeth in the creature that it doth not expatiate." Here the fact of transmutation is taken for granted, generation from putrefaction being sometimes called in as a *deus ex machinâ* to explain it. But Bacon certainly had no idea that the existing species of plants and animals represent those originally created by God, and this is what special creation means.

It might be supposed, however, that the doctrine of "special creation" was the private property of commentators, suggested by the account of creation given in Genesis. And there were, no doubt, those who so interpreted the words "after his kind." But Christianity was in no way committed to this view, while St. Augustine distinctly rejects it in favor of a view which, without any violence to language, we may call a theory of evolution. The greatest of the schoolmen deliberately adopted St. Augustine's views and rejected that of special creation. His words are so remarkable that they are worth quoting, especially as we have never seen them referred to in this connection:

> As to the production of plants, Augustine holds a different view. For some expositors say that on this third day (of creation) plants were actually produced each in his kind—a view which is favored by a superficial reading of the letter of Scripture. But Augustine says that the earth is then said to have brought forth grass and trees *causaliter*—i. e., it then received the power to produce them. This view he confirms by the authority of Scripture, which says, "These are the generations of the heaven and of the earth, when they were created, in the day that the Lord God made the earth and the heavens, and every plant of the field before it was in the earth, and every herb of the field before it grew." (Genesis, ii, 4.) Before then they came into being on the earth, they were made causally in the earth. And this is confirmed by reason. For in those first days God made creatures primarily or *causaliter*, and then rested from his work, and yet after that, by his superintendence of things created, he works even to this day in the work of propagation. For the production of plants from the earth belongs to the work of propagation.

Here, though there is no idea of the method by which the "kinds" were brought forth from the earth, or of their interrelations with one another, there is a clear conception of creation by

* "Natural History," Cent. vi, p. 523.

growth or evolution, which is quite contrary to what is known as special creation. And when we remember that the schoolmen held what is now called *abiogenesis* and generation from putrefaction, both in botany and zoölogy, we feel at once how infinitely more elastic their theory of Nature was than that implied in the doctrine of special creation. But if special creation is a doctrine unknown to Bacon and rejected by St. Thomas, it is not likely to be essential either to science or religion.

Where, then, did it come from? It includes elements both scientific and religious, and it is interesting to notice how the elements combined.

Half a century after Bacon's "Novum Organum" was published, a great poem appeared, which has since then, often unconsciously, influenced theologians and apologists. It is, no doubt, a thankless and ungenerous task to bring the heavy artillery of science to bear upon poetry, and it is only justifiable when truth is endangered. Some time ago Nasmyth, by the help of the "Nautical Almanac," discovered that, if Sir John Moore was buried "at dead of night," he could not have had the advantage of "the struggling moonbeam's misty light," because the moon must have been far below the horizon at the time. When this criticism was reported to the late President of the Royal Irish Academy by Sir R. S. Ball, he is said to have replied, "I'll tell you what it is, the time will come when that little poem will be taken as the sole authority about the matter, and all your astronomical calculations will go for nothing at all." This is very much what has happened in the case of "Paradise Lost." People have come to think of it as a sort of inspired gloss on the early chapters of Genesis. Yet there is a huge difference between the text and the commentary. In the Bible we have, "And God said, 'Let the earth bring forth,'" etc., words which are at least consistent with a gradual development. But Milton says:

> "The grassy clods now calved: now half appeared
> The tawny lion, pawing to get free
> His hinder parts, then springs as broke from bonds,
> And rampant shakes his brinded mane; the ounce,
> The libbard, and the tiger, as the mole
> Rising, the crumbled earth above them threw
> In hillocks; the swift stag from underground
> Bore up his branching head," etc., etc.*

This is literalism and realism with a vengeance! And yet it is hard to see why Milton should not do in poetry what Raphael in the Vatican had done in art.

But what gives such importance to the account of creation in

* "Paradise Lost," vii, 414, *et seq.*

'Paradise Lost" is, that it synchronized, curiously enough, with the first attempt to limit the logical term "species" to definite natural-history usage. This was the work of Milton's younger contemporary, John Ray, from whom the theory of the fixity of species may be said to date. Whether Milton influenced Ray, or Ray Milton, or whether the theory was "in the air," it is difficult to say. But in the next century, we find in Linnæus the meeting-point of Milton's *a priori* view of creation and Ray's unscientific doctrine of fixed species. The well-known words of Linnæus in the "Philosophia Botanica," "*Species tot sunt, quot diversas formas ab initio produxit Infinitum Ens, quæ formæ, secundum generationis inditas leges, produxere plures, at sibi semper similes,*" * are thus the first formulation of the theory of special creation, which angry evolutionists attack and unwise apologists defend. In Linnæus's own time it came to be generally accepted, though questioned by Buffon, who contended for the modifiableness of species. Popular belief in the Linnæan doctrine seems to have been shaken by Cuvier at the beginning of the present century, and destroyed by Darwin's "Origin of Species"; and yet the dead hand of an exploded scientific theory rests upon theology, and Christians, in all good faith, set to work to defend a view which has neither Biblical, nor patristic, nor mediæval authority.

It is difficult *a priori* to see how the question, except by a confusion, becomes a religious question at all. Writing to a lady who had consulted him as to the bearing of evolution on theology, Mr. Darwin says, "I can not see how the belief that all organic beings, including man, have been genetically derived from some simple being, instead of having been separately created, bears on your difficulties"; † and at the close of the "Origin of Species" he had written, in the same spirit, "I see no good reason why the views given in this volume should shock the religious feelings of any one." ‡

The Bible, no doubt, in its vivid consciousness of the omnipresence of God, speaks of everything as wrought by him. He makes the grass to grow. He feeds the ravens. He clothes the lilies. He lets his breath go forth, and the beasts of the field are made. Children and the fruit of the womb are his gift. He covers the infant in the mother's womb, and fashions its limbs as they are made in secret. Does any sane man suppose that this conflicts with what we know of the laws of growth and generation, or that it implies an obliterating or an abridgment

* [There are as many species as there were different forms produced in the beginning by the Infinite Being, and these forms, according to the prescribed laws of reproduction, have brought forth abundantly, but always like themselves.]

† "Life and Letters," ii, p. 247. ‡ P. 421.

of what we call natural processes? There is no doubt that a theory of "special creation," as against "creation by derivation" (for this is the true antithesis), possesses a strange attraction for some minds, just as some cling to a Calvinistic theory of "immutable decrees," though at the price of making God an arbitrary, if not immoral, despot. But we do not really make God more mighty by ascribing to him actions which are unintelligible, nor do we derogate from his power by showing that the Maker of heaven and earth is not autocratic, or capricious, or irrational, but works according to law.

It may, however, be said: "Creation is a great mystery. Why attempt to theorize about it? To speculate upon a mystery is to rationalize it." There seems to be only one answer to this objection, and it is that reason is the gift of God and not of the devil, and therefore it can not be wrong to try and understand what we believe. Preaching at St. Paul's on Christmas-day, on the supreme mystery of the Incarnation, Dr. Liddon says:

> It was perhaps inevitable that the question should be asked, How such a union of two natures which differ as the Creator differs from the creature—as the infinite differs from the finite—was possible? It might be enough to reply that with God all things are possible—all things, at least, which do not contradict his moral perfections—that is to say, his essential nature. . . . But, in truth, it ought not to be difficult for a being possessed of such a composite nature as is man to answer this question.

And he proceeds to draw out the analogy suggested and justified by the Athanasian Creed, "As the reasonable soul and flesh is one man, so God and man is one Christ." If it is not wrong, nay, if it is a very necessity of Christian reason to ask how the union of God and man is possible, it can not be wrong to ask, How is creation possible? and to answer it by the analogy of what we see and know.

But the moment this question is asked in the present state of scientific knowledge, two things become increasingly apparent: (*a*) the enormous difficulties which on the theological side alone a theory of "special creation" has to face; and (*b*) the remarkable gain to theology if evolution rather than "special creation" is true. In both cases we propose to put the scientific evidence for evolution on one side, and treat it as a bare hypothesis.

(*a*) Nothing has brought out the difficulty of the "special creation" theory more strongly than the modern science of comparative embryology. It has added enormously to our knowledge of the existence of (apart from its suggested explanation of) rudimentary organs, and rudimentary organs have always been a difficulty in the way of the "special creation" hypothesis. Take the case of the whale. As Prof. Flower pointed out at the Reading Church Congress, it possesses in the embryo state a

complete set of teeth, together with rudimentary hind-legs, furnished with bones, joints, and muscles, of which there is no trace externally. Both teeth and legs disappear before birth. On the theory that the whale is a descendant of a land-animal, which used both legs and teeth, they are intelligible as survivals in a creature to which they are apparently useless. But that God should have created these structures in a new being, which had no organic relation with other created forms of life, seems almost inconceivable. We can neither believe that they were created "for mere sport or variety," nor that they are "Divine mockeries," nor as an ingenious but anthropomorphic writer in the "Spectator" suggested, that God economically kept to the old plan, though its details had ceased to have either appropriateness or use. The difficulties are even stronger in the case of man and the now well-known facts of his embryonic life. How is it possible, in the face of these, to maintain that we have in man a creation independent of the rest of God's creative work? Of course, if the theory of "special creation" existed either in the Bible or in Christian antiquity, we might bravely try and do battle for it. But it came to us some two centuries ago from the side of science with the *imprimatur* of a Puritan poet. And, though scientific men are now glad to palm off upon theologians their own mistakes, religion is not bound to wear, still less to be proud of, the cast-off clothes of physical science.

(*b*) On the other hand, and again apart from the scientific evidence in favor of evolution, *as a theory* it is infinitely more Christian than the theory of "special creation." For it implies the immanence of God in Nature, and the omnipresence of his creative power. Those who opposed the doctrine of evolution, in defense of "a continued intervention" of God, seem to have failed to notice that *a theory of occasional intervention implies as its correlative a theory of ordinary absence.* And this fitted in well with the deism of the last century. For deism, even when it struggled to be orthodox, constantly spoke of God as we might speak of an absentee landlord, who cares nothing for his property so long as he gets his rent. Yet anything more opposed to the language of the Bible and the Fathers can hardly be imagined. With St. Athanasius, the immanence of the divine Logos is the explanation of the adaptations and unity of Nature, as the fact that man is *logikos* is the explanation of the truth that man is made in the image of God. Cataclysmal geology and special creation are the scientific analogue of deism. Order, development, law, are the analogue of the Christian view of God.

We may sum up thus: For Christians the *facts of Nature* are the *acts of God.* Religion relates these facts to God as their author; science relates them to one another as integral

parts of a visible order. Religion *does not* tell us of their interrelations; science *can not* speak of their relation to God. Yet the religious view of the world is infinitely deepened and enriched when we not only recognize it as the work of God, but are able to trace the relation of part to part—to follow, if we may say it reverently, the steps by which God worked, to eliminate, so far as possible, from the action of Him, "with whom is no variableness, neither shadow of turning," all that is arbitrary, capricious, unreasonable, and even where as yet we can not explain, to go on in faith and hope.—*The Guardian.*

SKETCH OF GUSTAV ROBERT KIRCHHOFF.

THE history of physics in our century is not poor in eminent thinkers and great investigators; but it is safe to predict, as Prof. August Heller remarks, that when the student of a future age takes his perspective view of the achieved results of our contemporary research, he will pronounce Kirchhoff one of the greatest of them all. Yet, although his works have made his name immortal, and must cause it always to be in mind where physics is taught, so simple and modest was he as he is presented to us in Robert von Helmholtz's delineation of him, that his person is quite hidden behind the science to which he devoted his life; and that few, except fellow-laborers in the same lines and those who were so happy as to have had close relations with him, are aware of the extent and importance of his labors outside of the field of spectrum analysis.

GUSTAV ROBERT KIRCHHOFF was born—the son of counselor-at-law Kirchhoff—at Königsberg, Prussia, March 12, 1824. Having passed the course of the Kneiphof Gymnasium, he continued his studies at the Albertina in his native city, under Neumann in physics, and Julius Richelot in mathematics; and there, in his eighteenth year, decided that physics was the branch that pressed the strongest claims upon his attention. It was a period of rapid progress and important discoveries in science. Mayer had published his first paper concerning the forces of inanimate Nature, on the eve of the working out by several independent observers of the law of correlation and conservation; the undulatory theory of light had been established, but its mathematical conditions and its adjustment to facts remained to be worked out; and the wonderful properties and powers of electricity were under investigation by students at different centers, whose names have since become identified with various aspects of electrical theory. Kirchhoff, now entering upon the study of these same

and related branches, was one of those fortunate young men, says Prof. Heller, who appear, by the nature of their faculties, to be specially adapted to their calling. His rare mathematical talent adapted him to the use of analytical aids to such an extent that he could always readily bring the best methods to the solution of any problem. On September 4, 1847, he took his degree from the University of Königsberg. In the following spring he began his professional career at the University of Berlin as a *Privat-Docent.* He had already, while a student, in 1845, published a paper in Poggendorff's "Annals" on electric conduction in a thin plate, and specially a circular one, to which were appended two theorems which have since become generally known as Kirchhoff's laws. This was followed by other valuable papers on electrical questions, among which were those on conduction in curved sheets, on Ohm's law, on the distribution of electricity on two influencing spheres, on the discharge of the Leyden jar, on the motion of electricity in submarine cables, etc. Among them also is a paper on the determination of the constant on which depends the intensity of induced currents, in which is involved the absolute measurement of electric resistance in a definite wire.

In 1850 he was appointed Extraordinary Professor and Codirector of the Physical Institute in Breslau, where he remained four years, and formed a life-long fellowship and scientific brotherhood with Bunsen. In 1854, Bunsen having preceded him thither, he removed to Heidelberg, where he had been chosen regular Professor of Physics, in place of Jolly, who had been transferred to Munich. Here he lived and taught for twenty years, the bloom-period of his life. The brightest days in the history of this great university, to whose fame and preeminence Kirchhoff contributed very materially, fell during the same period. To the general public, says Robert von Helmholtz, hardly anything was then known of Kirchhoff. His labors at Berlin and Breslau, being in a field wholly theoretical, had attracted the attention only of experts. "There was, therefore, some surprise in Heidelberg when the slender, remarkably youthful, modest, even bashful North German appeared, heralded by Bunsen's warm recommendations. His refined, animated speech, his courteous and attractive demeanor, his fine sense of humor and his wit, soon won him the liking of all men with whom he came in contact. He was, therefore, a welcome participant in all the social gatherings of the circle into which he fell. His friendship with Bunsen became very close. Bunsen was thirteen years his elder, strong and broad-shouldered, with a lively, commanding temperament, making his influence felt upon every one. The two men were thus quite different in their

outer aspects from one another; yet they not only pursued their great works in common, but also lived their daily social life together. They took walks in company in the environs of Heidelberg, and they traveled together during the vacations.

The discovery of the spectrum analysis is destined, like that of gravitation by Newton, and a few others, always to rank among the greatest achievements in the history of science. Newton had succeeded in separating white sunlight into its colored constituents. Wollaston had, in 1802, discovered the dark lines in the spectrum; and Joseph Fraunhofer had, independently, some ten years later, investigated those lines thoroughly, fixed the position of more than five hundred of them, and marked the principal groups with letters. Now, half a century afterward, Kirchhoff found the key to the remarkable phenomenon. For it is really the law of the relation of emission and absorption, as discovered by Kirchhoff, that furnishes the theoretical basis of spectrum analysis. More precisely expressed, this law declares that, for a given temperature and rays of the same color and polarity, the relation of the power of emission and absorption is the same for every body—that is, independent of the nature of the body. From this theorem it follows that a luminous body which sends out light-rays only of a certain wave-length, will also absorb rays only of the same wave-length. Under this law conclusions can be drawn from the dark lines of the solar spectrum concerning the constitution of the sun's atmosphere. Kirchhoff's first publication on this subject appeared in the monthly reports of the Berlin Academy for October, 1859. This short notice was followed by a rapid succession of papers describing the researches of the two investigators (Kirchhoff and Bunsen) upon the solar spectrum and the spectra of the elements.

While engaged in these investigations, Kirchhoff injured his vision by exposure to the glare of a clear spot in the solar spectrum, so that in later years he was obliged to spare his eyes. In 1867 he suffered an injury of his foot, in consequence of which he was for three years unable to get about except upon a perambulator or with the aid of crutches, and his health was affected for the remainder of his life. But the results of this personal mishap were seen in his physical life only, not in his labors.

In 1875 Kirchhoff accepted a call to the professorship of Mathematical Physics in the University of Berlin, after having previously declined two invitations to the same institution. Here he delivered for several years regular courses of lectures on the mechanics of solid and fluid bodies, the theory of heat and light, electricity and magnetism, mathematical optics, and special topics in hydrodynamics, electrodynamics, etc. "Whether life in Berlin," says Robert von Helmholtz, "is favorable to scien-

tific pursuits may well be doubted. The teacher, it is true, gains a wider, richer field of activity, but the investigator is robbed of a larger part of his time. Kirchhoff was, however, protected by his physical disability against most of the drive of the capital, and was able to labor as he had usually done. . . . His favorite work, and the one having the most enduring results, was his lectures on mathematical physics. His address was impressive by reason of the elegance and precision of his statement. Not a word was wanting, not a word was in excess; never an error, an obscurity, or an ambiguity. Remarkable also was the exactness of his calculations—a matter of extreme difficulty to laymen. The whole material arranged itself before the eyes of the class in the form of a nicely adjusted master-work of scientific art, so that every part exerted its full effect on the others, and to witness one of his deductions was a real æsthetic enjoyment. The complete understanding of his reasoning on these most difficult subjects implied, of course, some knowledge of the mathematical language which was his vehicle of thought; and it might happen, and did in fact sometimes happen, that a hearer could not comprehend why Kirchhoff made this particular deduction and not some other; but every one was able to follow his course of thought, consider it, and render it correctly. So that, paradoxical as it may appear, it was not impossible, without having really understood Kirchhoff, to reproduce his lectures from the notes into a respectable book. Kirchhoff was able to give his lectures uninterruptedly in Berlin for nine years. But we who heard him could remark the effort they caused him, and how he had to husband his strength. Yet he was always punctual, and the quality of his teachings was never depreciated. Finally, in 1884, the doctors forbade him to read; and although he was enabled to resume this his favorite occupation for a time, it was evident that his nervous system was shattered."

Besides the subjects we have already mentioned, Kirchhoff conducted a series of valuable investigations in the equilibrium and motion of elastic solids, especially in the form of plates and rods. His publications were not voluminous. His contributions to the Berlin Academy of Sciences are spoken of as having been about one a year. His collected papers (*Gesammelte Abhandlungen*), about fifty in number, were published in Leipsic in 1882, in a single volume. His lectures on dynamics (*Vorlesungen über mathematische Physik*), first published in 1876, have reached a third edition, at least. They are styled by Prof. Tait somewhat tough reading, but certainly recompensing the labor of following them. They form rather a collection of short treatises on special branches of the subject, than a systematic digest of it. His greatest work, "The Researches on the Solar Spec-

trum" (*Untersuchungen über das Sonnenspectrum*), was, almost immediately after its appearance, republished in an English translation. To these works, and the papers on radiation, partly mathematical and partly experimental, published in 1859 and 1860, which led up to the great work on the solar spectrum, he has added, so far as Prof. Tait has been able to discover, only three or four more recent papers, among which are one on the change of form which an elastic solid undergoes when it is magnetically or electrically polarized (*Berlin Abhandlungen*, 1884); a subsequent paper giving applications of the results in the same investigation; and additions to his paper on the distribution of electricity on two influencing spheres.

Prof. Heller says that Kirchhoff possessed in an eminent degree all the qualities most sought for in an academic teacher. Mr. Helmholtz sees in him the prototype of a genuine German investigator. The religion and object of his life was to seek the truth in its purest form, and express it with quite abstract unselfishness. He loved and cultivated science for itself alone, and deemed the slightest adornment or excursion from logical exactness in presenting it to be a profanation; while all mingling of it with personal motives or with the strife for honors or gain was most repugnant to him. As he acted in science, so did he in life; and what he recognized as a manly civic or official duty he pursued with logical thoroughness, divested of all personal motive. Winning amiability and goodness of heart were revealed in all of his personal intercourse, so that both in Heidelberg and Berlin he was one of the most popular of the academical teachers. He was fond of telling a story of how, when the conversation turned upon the question whether the Fraunhofer lines conveyed any information respecting the presence of gold in the sun, his banker asked, "Of what use is gold in the sun to me if I can not go and get it?" Afterward, having received an English gold medal for his discovery, he showed it to the banker, and said, "See, I have got some gold from the sun!" Having been compelled by his growing disabilities to retire from active life, Kirchhoff spent his last months with his family, preserving a living interest in the questions with which he had been occupied. He was never heard to utter a complaint, though he must have known that his powers were steadily passing away. Death came to him quite unexpectedly, while he was asleep, on October 17, 1887.

As described by Prof. Heller, he was of a stature rather under than above the average, with finely modeled, sharply cut features; having a high forehead, on which many years of continuous thought had engraved close and deeply cut wrinkles, while the penetrating glance of his deep-blue eyes bore witness to his habit of giving close attention to abstract thought.

CORRESPONDENCE.

A DIFFICULTY REGARDING EVOLUTION.

Editor Popular Science Monthly:

I did not see Mr. Royse's letter on this subject until to-day. As he desires an answer, I will say a very few words.

The substance of Mr. Royse's difficulty is this: The chicken comes from the egg—true; but the egg also comes from the chicken—the mature animal is evolved from the germ-cell, but the germ-cell is produced only by the mature animal. So has it been from the beginning. Which is first? Have we not quite as much evidence that the mature animal, as that the germ-cell or protoplasm, was first? Of the two, he thinks the former the more probable.

In answer, I would say that Mr. Royse is probably right. Life *did* commence with the mature organism. But, according to the evolutionist, the primal organism was both *germ-cell and mature;* for the germ condition and the mature condition, in the lowest forms of life, are identical. Such lowest forms, even now, can hardly be said to have an ontogenic history, for they simply divide and redivide without essential change. Life, the germ-cell and the mature organism, all came together at the same moment. How, we know not; but, once introduced, the theory of evolution gives the process of change during the geological history of the organic kingdom, and shows that it is similar to the ontogenic history of the higher organisms.

JOSEPH LE CONTE.

BERKELEY, CAL., *March* 9, 1888.

THE ECONOMIC OUTLOOK.

Editor Popular Science Monthly:

SIR: Readers of "The Popular Science Monthly" are greatly indebted to the Hon. David A. Wells for the large amount of valuable information which he has made both accessible and interesting in his recent articles on the "Economic Outlook in the United States." But, as could scarcely be otherwise, in handling such a vast mass of material as the extent of the discussion implies, he has sometimes fallen into errors of fact, to one of which I wish to call attention.

On pages 460 and 461 of the February number he says: "Forty years ago corn was shelled in the United States by scraping the ears against the sharp edge of a frying-pan or shovel, or using the cob of one ear to shell the corn from another. In this way about five bushels in ten hours could be shelled, and the laborer would receive about one fifth of the product."

Then Mr. Wells goes on to draw conclusions, giving the population of the great corn States as over 2,000,000, and saying it would be needful for the whole population to sit astride of pans and shovels for one hundred and ten days to shell the corn-crop of 1880.

Now, what are the facts? I have been over the great corn States mentioned, as well as Kentucky and Tennessee. I can go back more than forty years or even sixty, and know whereof I speak. Fifty years ago and more the farmer who wanted to convert his corn into whisky to send by flat-boat to New Orleans, thence to Cuba or Charleston, unloaded from one to two hundred bushels upon his barn-floor, and put from four to six horses to tramp it out, and in two hours he had 200 bushels shelled. This was vastly better than sitting astride a frying-pan or shovel and scraping off five bushels a day. I did it many times, and know just how it was done.

Again, when the farmer wanted to take a load of meal to the market, he threw a load of corn on his barn-floor, say forty bushels; then took the old-fashioned flail that hung in every barn, and in an hour he had his forty bushels shelled. This, too, was better than sitting astride his frying-pan or shovel. And let me say, for the honor of the "old flail" and its departed uses, that it was about as good a hand-sheller as any that were found in the old barns.

GRIFFITH MORRIS.

GLENDOWEE, OHIO, *February* 8, 1888.

A CORRECTION.

Editor Popular Science Monthly:

SIR: My attention has been called to a misquotation from Dr. C. F. Taylor's paper on "Emotional Prodigality," which occurred in my article on "Emotions *versus* Health in Women," printed in the February number of your magazine. Referring to Dr. Taylor's argument that emotional disturbances conduced to certain abnormal conditions in children, I have used the terms *diseases of the spine* as coming under his notice. This is an unintentional misquotation, as Dr. Taylor uses the terms *lateral curvature* and *lateral distortion;* and, that my own thought was not of diseases, but of these abnormities, the context will show. In the same paragraph (page 505) the second quotation, to be entire, should read: "I may say that at least two thirds of all *lateral distortions* of the spinal column are directly traceable to mental overaction,

mainly, if not entirely, of an emotional origin. There can be no doubt that this is the fact, because not less than three fifths of those who consult me in the earlier stages recover without any other treatment than a careful abstaining from whatever excites undue emotions in the subject of the distortion." My quotations were made from memory, and I regret that this error occurred, as the distinction is an important one.

If you will kindly give me room for this correction in your columns, you will oblige,

Yours very truly,

MARY TAYLOR BISSELL, M. D.

NEW YORK, *March* 5, 1888.

EDITOR'S TABLE.

HON. DAVID A. WELLS ON ECONOMIC DISTURBANCES.

IN the present number of the "Monthly" will be found the concluding article of the very interesting and valuable series contributed to our columns by the Hon. David A. Wells. The subject which this able and well-equipped writer has so amply discussed is one, it is almost superfluous to say, of the very highest importance. The condition of the body politic is a matter to which no one with the slightest pretensions to intelligence can allow himself to be indifferent. Is it well with us, or is it ill with us, in the social state?—surely that is a question which none but the ignorant or the frivolous can regard as other than most momentous. In discussing "economic disturbances" Mr. Wells has had this question constantly in view. He has written not as a mere statistician, or as a devotee of the market, but as a statesman, as a patriot, as a friend of humanity. Our readers can not have failed to notice the large spirit of humanity that breathes through his articles. We venture to say that no similar series of articles was ever produced more free from national prejudice or the spirit of national selfishness. Mr. Wells has watched, and has interested himself in, the whole movement of civilization; and he has the happy art of communicating to his readers a similar enlargement of thought and sympathy.

In the earlier articles of the series attention was called to the universality, among the more advanced nations of the globe, of a condition of economic disturbance dating from about the year 1873, and continuing, with more or less of fluctuation, to our own day. The evidence offered as to the reality of the phenomenon is, in the fullest sense, demonstrative; indeed, the leading economists of all countries are fully agreed as to the fact; divergence of opinion only begins with the discussions of the cause or causes. Without wishing to participate in the discussion ourselves, we must express our conviction that, in singling out as the great cause of the prolonged crisis under consideration the rapidity with which modes and conditions of production and transportation have changed during the last fifteen years, our contributor is essentially in the right. The picture he has drawn of the fluctuations in special trades, including displacements of labor, consequent upon the progress of invention and discovery, is striking and powerful; and it is not a matter of surprise that, when attention is concentrated upon this picture, a very gloomy forecast is apt to be formed of the immediate future of society. With displacement of labor, we see destruction of capital, financial uncertainty, and a growing feeling, on the part both of employers and employed, that they are the sport of forces that can neither be controlled nor calculated. No sooner is equilibrium partially restored, through a dearly-purchased adaptation to new conditions, than some further discovery comes to throw everything once more into confusion; nor does any one know the moment when our

whole industrial system may not be shaken to its base by the introduction of some new force or process more revolutionary in its effects than all that has gone before.

Evidently what is wanted for the production and maintenance of the highest form of social well-being is not only a large command over the forces of Nature, but a reasonable measure of stability in the general conditions of life. The lack of such stability entails evils not only material but moral; and we are inclined, after a careful reading of Mr. Wells's pages, to believe that in our present social state the latter predominate over the former. If the question be asked, Have the working-classes, in point of fact, endured greater hardships during the last fifteen years than during the previous fifteen, or in past times generally? the answer, according to Mr. Wells, must be an emphatic No. We may, indeed, go further on the strength of the facts he furnishes, and say that, up to the present, wages have been pretty steadily rising, while the purchasing power of money has been increasing. As a result of this double improvement in the remuneration of labor, the whole standard of living among the wage-earners has advanced. The skilled mechanic or artisan can to-day enjoy more both of comfort and of luxury than citizens of substantial means could have done a generation or two ago. On the other hand, if we turn to the capitalist class, and ask whether their losses and perplexities have depressed their mode of living, or diminished the outward and visible marks of their prosperity, we read the answer in the handsome streets of all great cities, and their suburbs. M. de Laveleye remarked a few years ago, with special reference to continental Europe, that one of the most conspicuous facts of the age was the vast increase in middle-class wealth and luxury; and certainly the phenomenon challenges attention at least as powerfully in this country. The very "strikes" that have marked our time have in themselves afforded evidence of general prosperity, showing, as regards the strikers, the possession of resources on which they could fall back during the period of their voluntary idleness, and, as regards the employers of labor, an ability to withstand the derangement of business which the strikes must have entailed. The truth would therefore seem to be, that our "economic disturbances" have involved more of unrest and anxiety than of actual suffering. Society has been, naturally enough, in a nervous, excited condition, and men's minds have been filled with apprehensions of evil that fortunately has not yet come to pass. Such a condition is not free from danger. Man does not now, and never did, "live by bread alone." He lives also by formed habits, permanent associations, settled views, well-grounded hopes. Take away any of these, and you not only unclothe but actually unbuild average human nature. It is not enough to supply bread. The bread-eater, if he is to thrive in mind as well as in body, must be enabled to feel that it is not all a matter of chance whether he gets the bread or not, but that there is some regular provision in the general scheme of things whereby his labor and thought can be transmuted into sustenance for himself and those dependent on him.

This view of the matter can not, we think, receive too much attention. Some one, rising from the perusal of these articles, may be disposed to exclaim: "Oh, it's all right after all. I see that wages are better than they used to be, and the working-classes enjoy a great many comforts they were not accustomed to formerly, and there is more work to be done in the world than there ever was before. Why, everything is splendid!" No, everything is not splendid. On the material side we are prospering, but the deep unrest that pervades society is not a

healthy symptom; and before we take our ease we should see what can be done to moralize the existing conditions of industrial life, and to give to the world's workers a conviction that the action of natural and social forces is making for their good and will continue to do so in the future. How is this to be done? By any form of government action? Upon this point Mr. Wells does not give us all the light we should desire to have; but we thank him for having shown, in the matter of the sugar bounties and drawbacks and kindred measures, the futile character of government interference with trade. On the score of restrictive tariffs much might have been said. If the little, comparatively speaking, that has been done by different countries to force their sugar upon other countries has been productive of so much disturbance as Mr. Wells describes, to what a vast extent must the natural course of industry and commerce have been interfered with by the hostile tariffs that different nations have erected in order to shut out from their markets the cheap goods that other communities were prepared to supply! Had the commerce of each country been required to adapt itself simply to the natural conditions established in the world, there would have been far more of permanence and less of uncertainty in all business arrangements; and a natural equilibrium would have resulted, the benefits of which would have been shared by all countries alike. But with tariffs enacted either by irresponsible autocrats or by more or less purchasable majorities of representative assemblies, wholly incalculable elements have been introduced, with results as grievous to commerce in its broad aspects as would be the shifting of the stars to navigation. But more injurious still than any actual financial loss resulting from government interference has been the habit which has thus been cultivated in most countries of depending on the government or the legislature, not only to control the channels of trade, but to secure the national prosperity. With all our boasted intelligence we make an absolute fetich of the state. "Whence have these men this wisdom?" might well be asked regarding the men who undertake to make our tariffs, and say just how much of this or that foreign article we shall import, and how much we shall pay for a similar native product. But few, comparatively speaking, ask the question: the assumption is general that the man who is elected to Congress and placed on a committee is thereby invested with a wisdom and knowledge almost supernatural in their range.

For our part, we do not share the delusion. We do not believe that any man or body of men is wise enough to be intrusted with the task of fettering the industry of a nation or prescribing the extent to which its citizens shall trade with other nations. We do not believe that election to any representative assembly whatever confers such wisdom. Holding such views, we are far from looking to government for any help in the present crisis. The only help, as we conceive, that the governments of the world could give would be to cease their interference with many departments of life which they now undertake to control. Leaving, then, every form of state action out of the question, we believe that much good might be done by the dissemination in a condensed and striking form of such facts as Mr. Wells has so industriously gathered; and we learn with pleasure that it is that gentleman's intention to republish his essays in book form, with such modifications as will best adapt it to popular usefulness. If the working-classes could be brought to understand the action of economic and social laws, and if it could be made clear to them that up to the present their own position had been steadily improving, they surely would not be dis-

posed to find much fault with the present tendency of things. If they could be persuaded that the instability of business was due in no small degree to government interference with commerce and industry, and that it would be greatly to their advantage to rely on a world-equilibrium in business matters rather than upon one made and unmade by national tariff legislation, their influence would probably be thrown in favor of commercial freedom, instead of, as is now the case, mainly in support of commercial restriction. Could they also be made to realize that, if their present increased wages, coupled with comparative lowness of prices, leaves them in many cases still in the grip of what seems like poverty, it is because they allow their desires for the enjoyments of life to outrun even their enlarged means. Any one may land himself in misery who does that. Finally, it can never be superfluous to preach the ever true doctrine that the key to happiness is conduct. Of those who really feel imbittered against the existing condition of things how many can truly say that they have been true to themselves; that they have made the most of their opportunities; that they have not, by some want of self-control, marred their own careers? No social state could by any possibility be invented in which a certain number of malcontents would not be counted. With malcontents, who are so by defect of nature or faults of conduct, the hand of power must deal. There is much good to be effected, we firmly believe, by dealing with men as men, individually intelligent and individually responsible, and doing away as far as we possibly can with the preposterous notion that they are pawns to be moved hither and thither by manipulators of the tariff and other gentlemen of protective proclivities. Self-help founded on knowledge is the master-principle of individual and national salvation.

We invite special attention to three articles on "Darwinism and the Christian Faith," the first appearing in this number of the "Monthly," which were recently published in "The Guardian," the leading Church journal in England. These articles are spoken of as "remarkable" by the editor of "Nature," who further characterizes them as follows: "The author is anonymous, but is understood to be an Oxford College tutor, and Honorary Canon of Christ Church. The orthodoxy of 'The Guardian' is, we believe, unimpeachable. We notice, therefore, with gratification that not only is Darwinism thoroughly accepted and lucidly expounded by the writer in 'The Guardian,' but that he is an exceptionally well-informed and capable critic, whose scientific knowledge is varied and sound. The publication of these articles in 'The Guardian' is a proof that the clergy as a body are not so unwilling to accept new scientific views as might be supposed were we to regard Dean Burgon as a fair sample of his class." The other two articles of the series will appear in early numbers of the "Monthly."

LITERARY NOTICES.

Evolution and its Relation to Religious Thought. By Joseph Le Conte. New York: D. Appleton & Co. Pp. 344. Price, $1.50.

This volume, by the Professor of Geology and Natural History in the University of California, is a notable contribution to a discussion perennial in its interest. No question to-day more profoundly stirs the minds of thoughtful Christians than how the philosophy of evolution shall modify their convictions. With every passing year it is becoming better understood that it is not with religion, but with theology, that science has had conflict. By a necessity, purely and simply historical, theology has united elements very diverse in value. Its core and essence, religion, has been presented in tenet and dogma always plainly limited by the time, place, and knowledge of creed-makers. With religion have been

associated primitive ideas of the divine mind and will—crude cosmogonies current at the beginning of recorded human observation. Conceptions, transient in character, have had alliance with religious sentiments, essentially permanent. When a traditional cosmogony, such as the Mosaic, is transmitted as of equal sacredness with religion, there is grave danger that science, in discrediting the cosmogony, may do hurt to religion. This danger is avoided when we discriminate between the transient and permanent elements in theology. There is not, and never was, any necessary connection between any theory of Nature's history and the kernel of religion—the sense of a supreme mystery behind Nature, the sense of moral obligation transcending utility, and the hope of everlasting life. The conflict which so many suppose to be between religion and science is more and more seen to be really between new science and old—if by stretch of courtesy primitive observation and theorizing can be called science at all. Timidity, half informed and careless in discrimination, imagines science to be intent on destroying the temple of religion, whereas its chiefest mission is to broaden and heighten it. The more intelligible Nature becomes to the student, the profounder his reverence for the Intelligence manifested in Nature. Evolution, as a philosophy, deals only with the history of Nature, not its origin; with its transformations, not its essence.

That evolution is truth, and axiomatic truth, Prof. Le Conte firmly maintains. His presentation of its proofs, though rapid, is masterly, and brought down to date. He sets forth the important and little appreciated work of Agassiz in this connection—his proof that the laws of embryonic development are also the laws of geological succession. Agassiz, however, holding as he did the doctrine of permanency of specific types, rejected the theory of the derivative origin of species. Prof. Le Conte then presents the factors of evolution tersely and concisely—the effects of physical environment, of the use and disuse of organs, of natural, sexual, and physiological selection. He brings forward evidence for evolution from the general laws of animal structure, incidentally discriminating between analogies and homologies. He compares the forelimbs of mammals, birds, reptiles, and fishes, part for part, in a specially able manner. Embryology is next summarized in proof of the derivative origin of specific forms, and the parallel between the development of an individual and of the species to which the individual belongs is brought out very forcibly. The significance of rudimentary organs—teeth in whales, the cæcum in man—is shown to depend solely on descent from forms wherein such organs were useful. Unexercised, they have dwindled, and tend to disappear. Evolution is next shown to be supported by the facts of geographical distribution. Isolation of the Australian continent at a remote geological era explains the primitive characteristics of its fauna and flora. The peculiarities of island-life, the rapid changes in organic forms during the last glacial epoch, and the recession of arctic species to the snow-line of the Alps and the high mountains of Colorado and California, are shown to be intelligible on no other hypothesis but that of evolution. Prof. Le Conte next surveys the testimony drawn from the artificial production of varieties, and presents with graphic illustration the law of cross-breeding.

While maintaining that the fact of evolution is certain, our author points out that all its laws are not yet fully understood. Among the difficulties which he considers are those of the uselessness in incipient stages of organs afterward developing into usefulness. In such stages, for example, fins probably commenced as buds from a trunk; it is difficult to see how as buds they could be of any use, and therefore how they could be improved by natural selection until they grew to efficient size, and especially until muscles were developed to move them. Again, in the case of a variety in a new and useful direction making its appearance, what has prevented its obliteration by cross-breeding with the parental form? Thus, while he holds the law of evolution to be even more surely demonstrated than the law of gravitation, Prof. Le Conte points out problems to which students may most profitably direct their powers of observation and generalization.

Because our author is thoroughly a man of science, he finds his knowledge in con-

cord with his religion. He sees that the theory of development demands a reconstruction of theology, and frankly says so. His own conceptions of the reconstruction necessary are modestly and clearly stated. His idea of Deity is that of a Being resident and immanent in Nature, who creates by means of natural law in a perfectly intelligible order. At the point in evolution where man became a morally responsible being, he deems the human soul to have been born. As physical evil has been the means, through the pain and struggle it has involved, of racial elevation, so he holds moral evil to be equally necessary for the growth of character. How, otherwise, he asks, than by the possibility of fall, could man have gained the strength to rise? Prof. Le Conte is instructive, suggestive, and candid throughout every chapter of his book. It will be fruitful and helpful to many who fear that the progress of science means the abolition of religion; that Darwin and Spencer have come to uproot sentiments which Galileo, Kepler, and Newton only elevated and deepened.

WEALTH AND PROGRESS: A CRITICAL EXAMINATION OF THE LABOR PROBLEM. By GEORGE GUNTON. New York: D. Appleton & Co. Pp. 382. Price, $1.

IN this book the author undertakes to establish a natural basis for industrial reform; to show how to increase wages without reducing profits or lowering rents; and to expound the economic philosophy of the eight-hour movement. Whatever may be thought of the sufficiency of his conclusions, the critic must admit that his doctrines and proofs are well thought out and clearly stated, without passion and without prejudice. The book really has a duplex origin, for its central thought was conceived and the first effort to state it was made by the late Ira Steward, the leader of the labor-reform movement in Massachusetts. Just before his death, in 1883, he made a request that Mr. Gunton should complete his unfinished work. This author had the advantage of extensive experience and exceptional opportunities for observation with industrial affairs, and had been a close student of economic questions. He perceived the magnitude and perplexity of the task imposed upon him, and has met it in the fashion of a manly thinker. This book contains about half of what he has to say, the presentation of the principles of social economics being reserved for another volume. The precise points considered in the present volume are the definition of the law and cause of increasing production, and the theoretical statement and historical establishment of the law of wages. Under the former head, the socialistic postulate, that "labor is the creator of all wealth," is shown to be fallacious, and it is maintained that—inversely to the general conception—the prosperity of the laborer is the basis of the capitalist's success. The "wages fund," Francis A. Walker's, and Mr. George's theories of the law of wages, are all dismissed as unsound, and the true theory is defined to be that "the chief determining influence in the general rate of wages in any country, class, or industry is the standard of living of the most expensive families furnishing a necessary part of the supply of labor in that country, class, or industry." This law is illustrated and enforced by a review of the conditions of workingmen's wages and modes of living in Asia and in Europe in the thirteenth and fourteenth centuries, and down to the nineteenth century. The standard of living is determined by the daily wants of the people concerned—not what they have vague desires to have, but what they will struggle to get. These wants regulate consumption, and that regulates production, and thus the prosperity of the capitalist and the community is determined. The standard of the wants is elevated by enlarging the social opportunities of the masses, but not by enlarging them faster than the capacity for enjoying them is augmented. The first step toward this end is a reduction of the hours of labor, for, without time to improve them, other means for promoting the same object —education, free lectures, public libraries, parks, museums, and art-galleries—are necessarily ineffectual. Yet this must be done wisely, and commensurably with the enlargement of other facilities; for, to give idle hours to a man who does not know how to use them aright, is only a curse. With this reduction, which it is proposed to make to eight hours a day, should go half-time schools for children at work under sixteen years of age. Among the immediate effects

of the measure proposed would be the employment of a great number of laborers who are now idle. The permanent effects would be most quickly seen in the younger laborers; for, by the application of half-time, "within a single decade every laborer of twenty years of age . . . would have had five, and many of them seven or eight years' daily contact with the educational, moral, and social influences of school life. It is clear, therefore, that the necessary consequence of the general adoption of the half-time school system alone would be not only to greatly improve and elevate the home, but to almost revolutionize the domestic and social atmosphere of the masses within a single generation." The effects of this system upon wages, production, and prices, on profits, and on rent, are next considered, and declared to be all beneficial. The feasibility of short-hour legislation is shown from the history of the measures in that direction that have been taken in England. The lessons which they teach are drawn from comparative reviews of industrial progress in England, continental countries, and the United States; the eight-hour and half-time system is presented as a social and political necessity; and the conclusion is expressed that if such a system could be uniformly adopted in the principal manufacturing countries, "its effect upon emigration, enforced idleness, business depressions, and upon real wages, together with the growth of intelligence and social character, would in twenty-five years change the face of the industrial and social institutions of Christendom."

We have received from Macmillan an *Elementary Chemistry*, by *Muir and Slater* ($1.25), and a *Practical Chemistry*, by *Muir and Carnegie* (80 cents), two books, adapted to university students, which are designed to be used together in learning the elements of chemical science. The former volume deals mainly with chemical philosophy, using descriptive matter to show the basis on which the principles of chemistry rest. Its companion embodies a course of laboratory work.

In the third edition of the *Manual of Analytical Chemistry*, by *John Muter* (Blakiston, $2), a considerable amount of special matter has been introduced, but, by means of a change in the style of printing, the bulk of the volume has been diminished instead of increased. This manual embraces both qualitative and quantitative analysis, and deals with organic as well as inorganic substances.

Sir *William Aitken's* little book on the *Animal Alkaloids* (Blakiston, $1) embodies a lecture delivered before the British Army Medical School, in which he summarizes the recent researches as to the poisonous effect of the leucomaines, and other substances formed within the body by the physiological processes.

The sixth edition of *Bloxam's Chemistry* has been issued (Blakiston, $4.50). This work includes both organic and inorganic chemistry, and its distinguishing features are its comprehensiveness and the large space it gives to technological applications of chemical principles. The number of experiments introduced is also large. The work has been carefully revised, and a large part of it has been rewritten for this edition. The first edition having appeared when metallurgy was still treated as a branch of chemistry, more space is devoted to it than is usual in modern chemical works. As the author had been for many years before his death, which occurred just after the present book had passed through the press, a professor in the Military Academy at Woolwich, England, the chemistry of the various substances employed in warlike stores is quite fully treated.

Prof. *Victor von Richter's Inorganic Chemistry* (Blakiston, $2) has reached a third American edition. The present edition contains a rather extended section upon the thermal behavior of bodies, and throughout the work frequent occasion is taken to call attention to the dynamical side of chemical reactions. The sections upon the pressure and condensation of gases, and that upon the dissociation phenomena, have also been considerably increased, while new facts relating to the elements and their derivatives have been introduced.

First Steps in Geometry, by *Richard A. Proctor* (Longmans, $1.25), differs from the common text-books on this subject in dealing mainly with the methods which the student should follow in finding out for himself solutions to geometrical problems. The

volume includes, also, notes to the first two books of Euclid, and added propositions.

Prof. *Proctor* has published, also, *Easy Lessons in the Differential Calculus* (Longmans, 90 cents), suggested, like the preceding book, by his own experience when a student under clumsy and unpractical teaching. In his treatment of the subject, he aims to show the need of a method of calculation dealing with variable quantities, and how such a method is to be used in practice. The integral calculus he has treated as a department of the differential.

Prof. *W. G. Peck* has added to his mathematical series an *Elementary Treatise on Analytical Mechanics* (Barnes, $1.65), which is intended to embrace all the principles of this science that are needed by the student of engineering, architecture, and geodesy. The methods and arrangement of the book are based on the author's long experience in teaching at the School of Mines, Columbia College.

The nineteenth edition of *Nystrom's Pocket-book of Mechanics and Engineering* (Lippincott, $3.50) has been revised and corrected by Prof. *William D. Marks*, who has added an elementary article on dynamic electricity, and one on the expansion of steam. In the form of notes, the reviser has stated some opinions of his own which differ from those of the author, and has given references to the literature of certain topics.

Higher Ground, by *Augustus Jacobson* (McClurg, $1), suggests a means of settling the labor question, which has become so troublesome. The author states the difficulty in a few pages, and then names as the remedy the extension of manual training to all the public schools of the country. He would meet the expense by a graduated succession tax. The latter half of the volume contains much information in regard to the courses and results of the training-schools in St. Louis, Chicago, Toledo, and elsewhere.

Another book which claims to solve the same problem is *Labor, Capital, and Money: Their Just Relations*, by *C. C. Camp* (D. W. Lerch, Bradford, Pa.). The author maintains that "the theory of Ricardo's law of distribution, and its modern renovation by Mr. George," are entirely fallacious. He charges the current commercial disturbances to the wrong use of money, and prescribes as a remedy the issuing of money in such volume as to reduce interest to the percentage of advancing wealth.

The Old South and the New, by *William D. Kelley* (Putnam, $1.25), consists of a series of letters describing the industrial and social condition of the people of the Southern States in 1887, as contrasted with their condition in 1867. The general tone of the book confirms the recent reports of wonderful enlivenment in the farm and garden districts of Florida, in the coal and iron country, and the new manufacturing cities of the South, while some mistakes that have been made are also pointed out.

Free Rum on the Congo: What it is doing, by *William T. Hornaday* (Women's Temperance Publishing Association, Chicago), concerns a question of vital interest to the friends of humanity, which is occupying a large degree of attention in all civilized nations. It is that of the unrestricted importation of liquors into Africa, which, under the license allowed by the Berlin agreement constituting the Congo Free State, has grown into a business of enormous proportions. The extent of it is shown by the grand total of 10,377,160 gallons—most of it adulterations of the vilest character—which were shipped thither in 1885 from five countries. The evils inevitable under such a traffic do not need to be described or named. Their magnitude is incalculable, and their effects are likely to endure through many centuries.

Slav or Saxon, by *William D. Foulke* (Putnam, $1.25), is a study of the growth and tendencies of Russian civilization, in which are briefly described the territory and the people of Russia, and the military autocracy, with sketches of Russian conquests, the history of Russia, the reforms of Alexander II, and the present despotism. The author urges Americans to give their moral support to England in the collision with Russia which is prophesied to take place in Asia.

The first number of a journal named *Congress* (The Congress Publishing Company, $1 a year) comes to us from Washington. Its purpose in life seems to be the dissipation of that troublesome surplus in the United States Treasury, for nearly everything which it proposes to advocate involves

heavy expenditures of public money, while it appears to have no interest in anything which tends to decrease taxation.

China: Travels and Investigations in the "Middle Kingdom," with a Glance at Japan, by General *James H. Wilson* (Appleton, $1.75), is an attractive book of travel, especially to the business man. It is the outcome of a trip to gather information as to the desirability of investing American capital in the building of railroads, and supplying other modern improvements in China. The natural features and resources of the country, the volume and methods of business, the bearing of government regulations and social customs on commercial affairs, and the attitude of the government toward alien enterprises, are all discussed. The book contains also sketches of Chinese and Japanese history, with entertaining descriptions of scenery, family life, amusements, and superstitions in both countries. A map of China accompanies the volume.

A great deal of information about a fascinating part of our own land is contained in *California of the South*, by Drs. *Walter Lindley* and *J. P. Widney* (Appleton, $2). The questions that would be asked by the tourist, invalid, settler, and investor here find full and definite answers. A description of the climatology of the Pacific coast comes first in the volume, and is accompanied by a colored climatic map of Southern California. In the second part of the book the overland trip to California, and the natural features, points of interest, hotels, trade, wine and fruit production, and mineral springs of the five southern counties are described, with statistics, maps, and illustrations. Short papers are added on "Comparative Valuation of Lands and Products," by General Nelson A. Miles; "Trees, Shrubs, and Wild Flowers," "Petroleum and Asphaltum," "Orange-Culture," "Public Schools," "Profits and Methods of Fruit-Raising," and "Ten Acres Enough," by other writers familiar with these special topics.

Under the Southern Cross, by *M. M. Ballou* (Ticknor, $1.50), is a gossipy account of the author's travels in Hawaii, Australia, Tasmania, and New Zealand. The purpose of the book is evidently to entertain rather than to instruct; not to furnish statistics for the merchant or student, but to contribute to the pastime of "fireside" traveling, which has so many devotees.

Section II of the special report on "The Fisheries and Fishery Industries of the United States" is *A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*, and is prepared by *George Brown Goode* and a staff of associates (United States Commission of Fish and Fisheries). The contents comprise separate papers on the fisheries of each of the Atlantic States, with accounts of the fisheries of the Gulf of Mexico, the Pacific coast, and the Great Lakes, and an appendix of "Historical References to the Fisheries of New England." The methods and results of these industries are described by towns and counties, and numerous tables of statistics are inserted.

The Bulletin of the United States Fish Commission, Vol. VI, for 1886, contains a very large number of letters from American and foreign correspondents of the Fish Commission relating to special topics in its department.

Geology and Mining Industry of Leadville, Colorado, with Atlas, by *Samuel F. Emmons* (United States Geological Survey, $8.40), forms Volume XII of the monographs of the Geological Survey. The investigation of this field was undertaken in 1879, and the report was practically completed in the fall of 1881, when an abstract of it was made, which has been published. The information is less timely now than it would have been immediately after it was gathered; for the thousands of persons who, a few years ago, were eager to know about the mines of Leadville, have either got the knowledge by experience—in many cases dearly bought—or have turned their attention in other directions. The development of the mines, too, has gone on rapidly, and the ores have begun to change from carbonates and chlorides to sulphides. Still, the thorough manner in which the work of the geologist in charge and his assistants has been done, and the liberal style in which it has been illustrated with lithographic and heliotype plates, make the mon-

ograph of permanent value. The first part of the report deals with the geology of Leadville, and of the Mosquito Range, to which is appended an account of the petrography of the district. Part II deals with the mining industry, and is followed by appendices on the chemical constitution of the ores and other rocks, and on smelting operations.

Mineral Resources of the United States for 1886, prepared by *David T. Day* (United States Geological Survey, 50 cents), is the fourth volume of a series devoted to the statistics of the mining industries. It appears that there has been a notable increase in the value of mineral products over 1885, the chief item in this gain being pig-iron. The volume contains a paper, by E. R. L. Gould, presenting the leading provisions of the mining laws of States east of the Mississippi River.

In his *Exercises in English Syntax* (C. W. Bardeen, Syracuse, N. Y.), Mr. *A. G. Bugbee* seeks to furnish a manual which shall give a large amount of drill and test work, without introducing any examples of false syntax. The last he regards as object-lessons in incorrect use, and of more than doubtful utility when employed in exercises for correction.

The Outline of Anglo-Saxon Grammar of Prof. *W. M. Baskerville*, of Vanderbilt University (A. S. Barnes & Co.), appears to be a well-composed work, clear and concise in its statements, and leaving no point without an intelligent endeavor to give it a satisfactory explanation—a thing which, in a language of the dark ages only, it is not always easy to do. A list of irregular verbs is added by Prof. James A. Harrison, of Washington and Lee University.

C. N. Caspar and H. H. Zahn, of Milwaukee, send us *Volapük: An Easy Method of acquiring the Universal Language, constructed by Johann Martin Schleyer*, prepared for English-speaking students by *Klas August Linderfelt*, Librarian of the Milwaukee Public Library (128 pages, 50 cents, paper; flexible cloth, 75 cents). Volapük is, so far as we know, the only serious extensive attempt that has been made to impose upon the public a language that has been deliberately manufactured in a scholar's study. As a novel experiment, and as a matter that may possibly throw some light on the way languages come into being and grow, we shall watch its fate with much interest. It is satisfactory to learn from Mr. Linderfelt that Volapük is not regarded as yet perfect; that Prof. Kirchhoff, of Paris, has already made some acceptable and accepted improvements in it; and that there is an authorized Volapük academy for the suitable regulation of these matters. This work is composed on the basis of Alfred Kirchhoff's *Hilfsbuch;* it has a key to the exercises and vocabularies, and it bears the marks of being the work of a competent hand.

We have sometimes wondered, if a universal language had to be imposed on mankind, why Italian, which is living and ready made, could not be chosen. Though not perfect, it fulfills most of the requisitions of the American Philosophical Society. It is absolutely phonetic; its word-roots are familiar to all European languages; its vocabulary, while ample, is modest in its proportions; its pronunciation is musical, and its structure is simple. Most of these points appear in Mr. *C. H. Grandgent's Italian Grammar*, (D. C. Heath & Co., Boston), which is the "result of an attempt to put into convenient form and the smallest possible compass all the grammar that the ordinary student in Italian will need." It is all contained, vocabularies included, in 124 pages; and the work is well done.

Prof. *Edward S. Joyne's German Grammar for Schools and Colleges* (Boston, D. C. Heath & Co.) is based on the "Public-School German Grammar" of Prof. Meissner, of Queen's College, Belfast, which is very popular in the United Kingdom. Some extension has been given to the scope of the work, with a view of fitting it to the wants of students of every grade, up to the point where the demand arises for the higher study of historical and scientific grammar. A college professor, who has examined the book carefully, describes it as characterized by a fullness of light everywhere, "and a fullness of matter that will in most cases suffice," and as demonstrating "how superior scientific methods are to the so-called practical methods."

Memoirs of an Arabian Princess, by *Emily Reute* (D. Appleton & Co., 75 cents),

is the autobiography of a princess of the house of Zanzibar who became the wife of a German gentleman and made her home in Hamburg. The lady was a sister of the Sultans Madjid and Bargash; and her book is of interest as giving a representation of family life in Eastern courts. A darkly shadowed portrait is drawn of Sultan Bargash.

The collection of Mr. *Beecher's Patriotic Addresses*, published by Fords, Howard & Hulbert, contains the more important addresses and contributions to periodicals made by Mr. Beecher in America and England, from 1850 to 1865, on slavery, the civil war, and the development of civil liberty in the United States. The list begins with the article "Shall we compromise?" written in 1850, during the pending of Mr. Clay's "Omnibus Bill," when the issue on which the country was to divide politically was for the first time clearly defined and set forth, and closes with the eulogy on Grant. The intervening addresses—even though we may not agree with the editor in giving Mr. Beecher prominence after Lincoln and Grant, to the exclusion of others, in influencing the destinies of the country—are as essentially a part of the history of the times as any other single series of events. Mr. John R. Howard, the editor of the papers, who was a close personal friend of the author, introduces them with a well-balanced review of Mr. Beecher's remarkable personality and his influence on public affairs. Excellent portraits are given of Mr. Beecher in his mature manhood, at sixty-five, and a year before his death; and portraits, which ought to have been better ones, of the prominent men of the anti-slavery controversy.

The latest volume of Mr. *Bancroft's History of the Pacific States* (The History Company, San Francisco) is marked the ninth, and is the sixth and concluding volume of the *History of Mexico*. It gives the story from 1861 to 1887, with accounts of the invasion by the three powers and the setting up of Maximilian as emperor; the struggle of the Mexicans against the usurpation, ending in its final overthrow and the execution of Maximilian; and the presidencies of Juarez, Lerdo de Tejada, Gonzalez, and Porfirio Diaz. The general progress and present condition of the country are summed up in Chapters XIX to XXVI, under the heads of "Government, Finances, and Military"; "Mining, Manufactures, and Fisheries"; "Commerce and Railroads"; "Agricultural Resources;" "Ecclesiastical Affairs"; "Society"; and "Education, Science, Arts, and Literature." Of the condition of science in Mexico, we learn that the National Observatory, established in 1878, includes a meteorological and magnetic observatory, and maintains relations with the chief observatories of foreign nations and with many scientific associations. The Central Meteorological Observatory was established in 1877. A geological society was established in 1875. The Geographical and Statistical Society has contributed to the diffusion of knowledge on many subjects, particularly in connection with Mexico. "The conclusion arrived at, after a fair investigation of facts, is that many sons of Mexico have made great strides in the acquisition of science, and that a number of them have excelled in its several branches, and are doing their part well in the transmission to others of the knowledge they possess."

Except in the reduction of the pages to crown octavo size, *The First Edition of Shakespeare*, published by Funk & Wagnalls, is an exact photographic reproduction of the first folio edition of 1623. This edition is very rare, and of great value, principally because it is the only authority for the texts of "The Tempest," "Macbeth," "Twelfth Night," "Measure for Measure," "Coriolanus," "Julius Cæsar," "Timon of Athens," "Anthony and Cleopatra," "Cymbeline," "As You Like It," and "A Winter's Tale." It possesses an additional temporary value in view of Mr. Donnelly's Bacon-Shakespeare speculations, which are derived wholly from the peculiarities of this text. These peculiarities being given here in exact fac-simile, those interested in the questions raised by Mr. Donnelly can by its aid make their own comparison of his deductions with his evidence.

The magazine entitled *Woman* (Woman Publishing Company, New York, $2.75 a year), whose first number was that for December, 1887, is largely literary in character, and devotes considerable space also to the religious, temperance, and political efforts of women. Household economy receives a moderate share of attention.

The National Sin of Literary Piracy, by *Henry Van Dyke*, D. D. (Scribner, 5 cents), is a clear and vigorous statement of the moral position of the American people with respect to the intellectual property of foreign authors. It is an excellent document for the campaign for international copyright.

Madam *Emma Seiler's* treatise on *The Voice in Singing* (Lippincott) comprises the chief scientific facts, many of them the discoveries of the author, which lie at the basis of the art of singing. At the outset of her career as a teacher of vocal music, Madame Seiler perceived the need of a scientific foundation for her art, but the best instructors in Europe were ignorant of the laws which she sought. Applying to Helmholtz, who was prosecuting an inquiry into this subject, she was permitted to take part in his investigations, and also made important discoveries by herself. Later she received further assistance in her studies from Du Bois-Reymond. This book opens with a brief sketch of the history of vocal music, and the subject is then treated successively on the physiological, physical, and æsthetic sides. The structure of the vocal organs is described in an appendix.

Canadian Leaves (N. Thompson & Co., New York) is the title of a series of papers on the history, art, science, literature, and commerce of Canada, read before the Canadian Club of New York. Among the contributors are Prof. Goldwin Smith, Hon. Benjamin Butterworth, Rev. George Grant, and Mr. Erastus Wiman. Mr. *G. M. Fairchild*, jr., is the editor. The volume is handsomely made, and is illustrated with portraits of the contributors, head-pieces, initials, and tail-pieces, by Thomson Willing.

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POPULAR MISCELLANY.

The Meaning of Easter Eggs.—Larousse's "Dictionnaire Universel" says: "The use of Easter eggs is general among all the people of the different Christian communities. It appears to have been a symbolic tradition of the Christian Church, which has been explained in different ways. Some see in it a remembrance of the red egg which, according to Ælius Lampidius, a hen belonging to the parents of Alexander Severus laid on the day of his birth. Others trace it to the martyrdom which was inflicted upon Christians by the *ova ignita*. Among pagans, the egg had a mystic sense, relating to the origin of beings and of the whole world; and it is perhaps the case that this tradition was preserved, along with many others, in the new religion. The most probable interpretation, however, is that the Christian adepts saw in the egg, in view of the phenomenon of its hatching, a symbol of the resurrection of Christ; and hence the custom of carrying eggs to the temple on Easter-day to be blessed by the priest, which were afterward distributed to the family and friends. But it may be that there is in this nothing more than a joyful manifestation on the occasion of having again eggs of which the laity had been deprived during the whole of Lent."

The Audubon Monument.—We are glad to observe that the Audubon Monument Committee are moving as rapidly as the public will support them in their noble object of erecting a worthy monument to our first great naturalist. The enterprise is under the immediate care of our ornithological and scientific societies, in whose behalf the committees are acting; but contributions are desired and solicited from the general public. Audubon gave luster to the American name when it was in low esteem in science; and his service in literature was hardly less conspicuous. He was, moreover, a man of the people, who taught them and is still teaching them; and it is eminently proper that the people should unite in giving him the proposed testimonial of their grateful remembrance. The monument will be the first erected in America by popular contributions in honor of a scientific man; it is

expected to cost ten thousand dollars, and it is intended to stand in Trinity Cemetery, overlooking the Hudson, and not far from the Audubon mansion. All gifts will be publicly acknowledged. They may be sent to William Dutcher, No. 51 Liberty Street, New York. A committee of the Linnæan Society, consisting of L. S. Foster, C. S. Allen, M. D., and Jonathan Dwight, Jr., are co-operating in this enterprise, to whom gifts may also be sent, 11 West Twenty-ninth Street, New York.

British North Borneo.—The portion of Borneo ceded to the British North Borneo Company is of about the same size with Scotland, mountainous on the western side, and having large slopes and flats on the eastern side. Among the mountains is the Kina Balu, more than 13,900 feet high. Several rivers rise near the west coast, and, following a very long and winding course, fall into the sea on the east. The junction of several of these forms the Kina Batangau, a noble stream navigable by large steamers for 150 miles. On one of the tributaries of this river, the Quarmote, are the Alexander Falls, said to be a grand cataract, but never yet seen by any European. The rivers on the east coast run through an uninhabited virgin forest. On the west there is a fair population. From the healthfulness of its climate, the equableness and moderate heat of its temperature, the absence of physical disturbances, and the prodigious natural wealth with which it abounds, North Borneo promises to support a very large population. Ferocious wild animals are absent, while large game appears to be plenty. Valuable timber exists in great quantities, and is accessible; and, after the wood has been cleared off, the ground will be available for cultivation.

Philosophy of Combinations of Capital and Labor.—In an address before the Christian Conference which was held in Washington last December, ex-Mayor Low, of Brooklyn, held that the combinations of capital and labor, as represented by the corporation and the trades-union, are not necessarily antagonistic to one another, but are really different manifestations of the same force—the force which emphasizes the interdependence of society as against the individualizing forces of popular government. If the working on one side has resulted in wrong, it is equally the case on the other side; but the corporation is liable to the imputation that it is without sympathies and without a conscience. The workman is under the disadvantage that in the present minute division of labor his occupation has become almost wholly mechanical, and in case of the loss of his single function he has no resource. This belittling of the workmen's life has doubtless aggravated their sense of antagonism to capital. The same influences which have reduced the workingman in his daily scope have widened indescribably the privilege and opportunity of capital. Has capital appreciated as it should the responsibility and the duty which come with the privilege?

Mother-of-Pearl in the Red Sea.—The mother-of-pearl fisheries of the Red Sea extend the whole length of that water. About three hundred boats are employed by the Arab tribes who are engaged in the work—open, undecked boats, of from eight to twenty tons burden, carrying a large lateen sail, manned by crews of from five to twelve men, and each provided with a number of small canoes. There are two fishing seasons during the year, one of four and one of eight months, during nearly the whole of which the boats keep the sea. Fatal accidents are said to be unknown among the divers, and they are remarkable for their strength and good health. They dive between the ages of ten and forty years, and the practice is said to have no ill effects. Operations are conducted only in calm weather, when the shell can be discovered by the eye at a depth varying between seven and fifteen fathoms. Of late years, empty petroleum tins, with the ends knocked out and a sheet of glass inserted in one end, have been used to assist the eye. The glazed end of the tin is submerged under the sea, when a much clearer and deeper vision is obtained. During the last ten years the find is said to have diminished, owing to the dearth of shells, from ten to twenty per cent in quantity. Shells brought to Jeddah for sale are disposed of at public auction in heaps of about half a hundred-

weight each. As preliminary inspection is not allowed, the bidding is purely speculative. The bulk of the shells are now sent to Trieste, a small number to London, and a few to Havre; and some of the finest and largest shells are purchased for exportation to Bethlehem, where they are engraved and sold to pilgrims.

Games of the Greek Islanders.—Some of the games of the Greek islanders are described by Mr. J. Theodore Bent, in an article on "Greek Peasant Life," as wild, some as amusing, and some as distinctly traced to antiquity, "as probably all could if we had ample records to go upon." At Eastertime the maidens of many islands have the game of swing. They hang a rope from one wall of the narrow village street to the other. On this they put some clothes to form a seat, and two maidens seated side by side, facing in opposite directions, swing, and as they swing sing local ditties, plaintive for the most part, and in a high, shrill voice. The young men try to pass by, and are called upon for a toll of a copper apiece, a song, and a swing. They generally sing such words as these: "The gold is swung, the silver is swung, and swung, too, is my love with the golden hair." To which the maiden replies, "Who is it that swings me, that I may gild him with my favor, that I may work for him a fez all covered with pearls?" Having paid his copper, the youth is allowed to pass, and another comes by and does likewise. These games at Volathia, in Karpathos, take place on the Sundays in Lent, when the young men who are home from their work on this day can be present. "We are strongly reminded of the game of swing which the maidens of Athens played in remembrance of the death of Erigone, who hung herself from a tree, when they sang plaintive ditties in honor of her name and garlanded themselves with flowers, whereas now they sing solemn ditties about the passion and resurrection of our Lord. Among the games played by the boys of Samos, I saw one which bore a curious resemblance to single-wicket cricket. They call it 'ball,' σφαῖρος. There are five players on each side. One side is in; the other fields. The one who is in defends his wicket, a stone erected on the grass, with his hand. When he hits the ball he does not run, but counts one when the ball is sent beyond a certain boundary-line they have. If the ball hits the stone, he is out. In the mountain villages of Samos may still be traced in various forms the ancient game of δακτύλον επάλλαξις, which we can see depicted on a vase for us in the Munich Museum. It exists still in Italy under the name of *morra*, but in its simplest form it has survived in Samos. We saw two little boys playing together. One leaned against a wall, head downward; the other placed his two fists one above the other on his playfellow's back. 'Which hand is uppermost?' he cried. The other guessed. 'No, it isn't,' was generally the reply, accompanied by a pretty smart smack. A more elaborate form of this game is when two boys, leap-frog fashion, stoop down, the foremost against the wall, and the hindermost helping him. A third boy leaps on the back of the one nearest to him, extends a certain number of fingers, and cries, 'How many fingers in the air?' The front boy has to guess, and if wrong receives a smack from the rider. Not only among boys is this a popular game, but πόσα, 'How many?' is a favorite game at village-feasts. Six men were playing it when I saw it, three on each side. The three on one side were called the beasts of burden, that is to say, they turned their backs to the other three, who jumped upon them. Having done this, one of the riders put one hand over the eyes of his 'beast of burden' and held the other in the air, and as he did so extended some fingers and closed others, and cried, πόσα, 'How many?' If the beast of burden is stupid in guessing the right number of fingers extended, he receives sundry boxes on the ears and general rough treatment from his rider amid the laughs and jeers of the bystanders. When all three beasts of burden have guessed aright, they change places with their riders, who have to guess in their turn."

Preparation for the End of the World.—Some of the people of Birmingham, England, conceived recently that the end of the world was at hand, and adopted various queer means to mitigate the effects of the dreaded event. Old women went to their Bibles,

and younger women to bed. Three women, failing to get the protection they sought from a policeman, clubbed their pennies to buy a Bible. Other persons, thinking that the world was to be set on fire by the collision of two stars, believed that it would be safest to avoid the streets. A story is told of an old nurse, on another occasion, who, imagining that a very heavy and dark thunder-storm meant the end of the world, went up-stairs and put on her best cap. In another thunder-storm, conveying a similar suggestion, a panic-stricken sufferer lamented that the parson was not at home. On the morning after a storm on the island of Sark, which nearly blew the house over, the old housekeeper addressed her master: "Eh! Mr. B——, did you hear the wind? Eh! I thought the day of judgment had come." "And what did you do?" the master asked. "Eh! Mr. B——, I got up and made myself a little cup o' tea."

Some Principles of Chemistry-Teaching.—A paper by Lillie J. Martin, of the High-School, Indianapolis, on "Chemistry in the High-School," contains some good thoughts on the subject of teaching the science. While historical study, rightly carried on, does not preclude work that gives the kind of discipline that science should give, and itself has many advantages, "the great danger is that the distinctive aims of science-study will be lost sight of in the historical study," as is alleged to be done in too many text-books. At the bottom of the author's system of teaching lies the principle that the peculiar discipline of chemistry-study comes through the proper use of the laboratory. In practice, she divides the time about equally between getting the facts, or laboratory-work, and considering the facts, or class-room work. Simple apparatus, made or adapted by the pupil, is pronounced the best; and her own description of the apparatus recommended shows how the most common things, some of them costing nothing, may be made to serve. Four kinds of experimental work are declared to be too much neglected in high-schools: work that teaches pupils the use of their senses; work that acquaints them with the underlying laws of the science; work that throws them on themselves, or independent qualitative analysis; and work that teaches scientific exactness, or quantitative work. Encouragement of pupils to do original work and write about it when they have done it is insisted upon. Many experiences have taught the author that even the best text-books should be preceded by work which would throw the pupils upon the use of their senses in learning their lessons. In her own teaching of laboratory-work, in order to save time, experiments to be done on a certain day are indicated the day before, and are learned by the pupil; and general directions as to the particular way of doing each experiment are given at the beginning of the experiment-hour. By a little encouragement pupils will do a good deal of extra experimental work, and much of this can be done at home, with great gain in independence and originality. The ability to write what is laid down in the text-book is not a sufficient test for promotion in chemistry. The "literary test" in examinations makes pupils feel that chemical information is the thing to strive for; and, to counteract this tendency, the author suggests, in a question, that high-school laboratories should be opened for a practical test during examination, to make pupils understand that a knowledge of chemistry means the ability to deal with Nature.

The Origin of "Manners."—Otto Goldmeister, in writing on the usages of politeness, treats the subject as a universal one, the adequate treatment of which would have to include all people, of all times and places, and of every degree of barbarism and civilization. An institution thus coextensive with mankind can not have originated in convention or the caprice of some small social groups, or have been the product of any particular period of time. The presumption is therefore justified that the social code of manners has some kind of a bearing on the development and welfare of the race, and that it contributes to some end that can not be so easily reached in any other way. The essence of courtesy consists in our using the outer signs of esteem toward a person whom we do not know or may inwardly despise, in order to place ourselves in a position in which we

may deal with him for the time being without inconvenience. In doing this, we regard the other person simply as a fellow-member of the human race, and say to him by implication: "The good elements of the race command my respect. I will presume that you belong to them, but I have at present no occasion to inquire whether that is so or not. I will act upon this presumption till the contrary is shown. Deal with me on the same principle." We must look for the origin of the outer manifestations of courtesy to the signals of peace manifest among savage tribes and rude men. As manners become ameliorated, what in the beginning meant "Your life is safe," comes to mean "You are welcome." Some of the manifestations may be traced directly back to gestures, or to attitudes showing the person using them to be unarmed. He stoops as if to drop his weapons; he holds up his empty hands; he crosses his arms upon his breast; he kneels, or he touches the ground with his forehead. From these come the "present arms" of the military service; from the taking off of the helmet came the opening of the visor of the old knights and the raising or touching the hat of the modern salutation; and possibly from the raising of the empty hands, the "shake-hands" gesture of the present time. The idea that we pay honor to another by standing in his presence is doubtless a survival from times when more scanty provision was made for seats than now, and the best place was given to the preferred person.

A Remarkable Specimen of Rock-Crystal.—Mr. George F. Kunz exhibited to the American Association some remarkably large specimens of rock-crystal from Ashe County, North Carolina. His attention was first called to the locality by receiving from there a fifty-one-pound fragment which was said to have been broken from a mass weighing three hundred pounds, by a mountain-girl twelve years old. Other specimens from farms in the same neighborhood were a remarkably clear twenty-pound half-distorted crystal, one weighing one hundred and eighty-eight pounds, and another—twenty-nine inches long, eighteen inches wide, and thirteen inches thick, showing one pyramidal termination perfect, and another partly so—weighing two hundred and eighty-five pounds. These localities are on a spur of the Phœnix Mountain, about fifty miles from Abingdon and forty miles from Marion, Virginia. The crystals were all found in disintegrated crystalline rocks, consisting principally of coarse feldspathic granite, which have all decomposed to a greater depth than their position. Most of them are obtained by digging where one crystal has been found, or by driving a plow till some hard object is struck. Several dozen have been found weighing from twenty to thirty pounds each. Some of these crystals afford larger masses of clear rock-crystal than have ever before been found in the United States, and suggest the use of that substance for such objects of luxury as crystal balls, clock-cases, mirrors, etc., of which examples may be seen in the Austrian Treasury at Vienna.

Origin of River-Swamps.—Prof. N. S. Shaler has observed, in studying the fresh-water swamps of New England, that those rivers which flow southwardly run in clear beds, through valleys that are free from swamps; while the valleys of all the rivers flowing to the north are swampy. The former rivers flow freely, the latter are sluggish. He believes that this condition may be accounted for as the result of successive movements or changes of level which took place during the Glacial period, or at and after its close, the succession having probably been as follows: 1. The subsidence of the land-surface under the weight of the ice to a depth below the level of the sea; 2. With the retreat of the ice, a re-elevation, in a sudden manner, to a height above the level of the sea; and, 3. With the disappearance of the ice from the continent, a readjustment of its position and a consequent lowering of the southern portion of the glaciated area. It is not likely that in the readjusted condition of the continent all parts are equally elevated or equally lowered. The present levels of the several divisions of the continental area would probably be determined by complicated equations of thrusts, and it is probable that in this way we may explain the fact that certain of the lesser valleys of New England show little effect from the tilting movement

which in immediately contiguous areas has had a great influence in the flow of the streams. The author observes that the facts upon which his conclusion is founded throw much light upon the pre-glacial attitude of the continent. These river-valleys retain the general form which they had before the last glacial ice began to act upon them, and they pursue their present courses because their flow is mainly determined by the existence of the pre-glacial river-valleys in which they lie. It is clear that these valleys could not have been excavated by streams of their present slope; it seems, therefore, necessary to assume that the descent of the northward-flowing rivers must have been more rapid in the pre-glacial times than it is at present, or, in other words, that this part of the continent was at that time relatively less elevated in its northern parts than it is now.

Products of the Cowles Electric Furnace.—In the American Association, Professor C. F. Mayberry gave some additional information to that which he had previously communicated concerning the aluminum products from the Cowles electrical furnace. The efficacy of charcoal in promoting an intense heat (see "Monthly" for November, 1885) had been increased by coating it with lime; and the quantity of the product was augmented by modifying the direction in which the electrodes were introduced. Some erroneous statements by foreign electricians were referred to. Among them was a remark by Dr. Martins that they did not need to be informed by Americans concerning aluminum or its alloys. No direct answer was made to this, but the tenor of the facts cited by Professor Mayberry was to the effect that that was a subject on which they had still room to be informed.

Chinese Grass-Cloth.—The fabric known as Chinese grass-cloth is made from the fiber of nettles (*Boehmeria nivea* and other species) which are cultivated in China, and grow in India and Ceylon. They are perennial, herbaceous plants, having broad oval leaves with a white down on the under sides, and are stingless. The fiber is worked with much skill in China, but no important manufacture of it has been developed in India. The Indian Government some time ago offered a reward for an economical method of preparing the fiber, and the want has been partly filled by two French inventions, by one of which the stems of the nettles are decorticated and freed from glutinous matter by steam-treatment, and by the other the fibers are converted into a tow ready for spinning. The cloth manufactured from this fiber is glossy, has a peculiar transparency, and is of beautiful texture; and, as belting for machinery, has double the strength of leather belting.

NOTES.

THE many American friends of Mr. Herbert Spencer have frequently been pained during the past two years by the very discouraging reports concerning the state of his health, and the fear has been expressed that he would be unable to do any more work. We take much pleasure in stating, on the authority of a private letter from an intimate friend of Mr. Spencer, that there has been an improvement in his condition so great that the writer characterizes it as a "wonderful restoration to health."

THE most extensive forest plantations in the United States mentioned in the "Report" of the Division of Forestry are those of the Fort Scott and Gulf Railroad, and of Mr. Hunnewell, near Farlington, Kansas, of about 640 acres each, Mr. Burnett Landreth's plantation, of 300 acres, in Virginia; those of the Messrs. Fay and others, along the sea-coast of New England; and some of considerable extent in southern California. Small groves abound in the prairie States, and are found less frequently in the Eastern States, notably in New England. In the aggregate these plantations must amount to a considerable area. Forest commissions or bureaus have been instituted in New York, California, Ohio, and Colorado.

THE nomenclature adopted by the International Geological Congress to express the taxonomic rank of stratigraphic or chronologic divisions is thus summarized by Mr. G. K. Gilbert in his address before Section E of the American Association: Of stratigraphic divisions, that with the highest rank is *group*, then *system*, then *stage*. The corresponding chronologic divisions are *era*, *period*, *epoch*, and *age*. The word *formation* is restricted to the special function of designating mineral masses with reference to their origin. No word having been suggested in its place to denote indefinitely an aggregate of strata, Mr. Gilbert proposes *terrane*, and, for the corresponding chronologic term, *time*.

Of eighty-eight species of weeds described by Mr. L. H. Pammel, of St. Louis, as growing in southwestern Wisconsin and southeastern Missouri, forty-six are of European and thirty of American origin. One third of the latter class, and nearly one fourth of the entire list, are composites.

Pathologists have believed for many years that the material cause for intermittent fever is generated in the soil, and acts through the air. The discovery by Tommasi-Crudelli and Klebs, in malarial soil, of a bacillus capable of producing febrile symptoms was competent to illustrate the agency of the soil in the matter, but did not pursue the malarious influence into the atmosphere. The last has now been done by Professor Schiavuzzi, of Pola, who has obtained a bacillus from the atmosphere, indistinguishable in structure from that of Tommasi-Crudelli, which also produces in animals the characteristic symptoms and pathological changes belonging to ague.

There is an orange-tree in the gardens of the Palace of Versailles that is more than four hundred and fifty years old. It is called the Grand Constable, and was planted at Pampeluna, about 1416, by Eleanor of Castile, Queen of Charles III of Navarre. It was transplanted to Chantilly and Fontainebleau, and finally to Versailles in 1684.

A new system of sewage works has been put into operation at Henley-on-Thames, England. Its object is to avoid the discharge of the sewage into the river—which can no longer be allowed—and lift it to a level which will permit it to be used for irrigation. Ejectors are placed in different parts of the town to receive the sewage, and from there it is forced by compressed air into tanks about a mile distant, and 180 feet higher in elevation. The method is not costly, it is proved practicable, and it may offer a successful solution of the question of the disposal of the sewage of low-lying towns.

The English Home Secretary, recognizing corporal punishment as a fact, is giving attention to means of regulating it according to the physical condition of the child, so that it shall not bear too hard upon the weak. It is proposed to make the weight of the rod bear some proportion to the age of the child, and to permit the interposition of a medical veto in case of evident weakness.

A considerable extension of long-distance telephoning was effected during 1887. At the close of the year twenty-five circuits were at work between New York and Philadelphia, the chief points in Connecticut had been connected, and lines were projected to Worcester, Boston, Albany, and Washington.

An argument against allowing children to drink milk in the summer-time is drawn by Dr. V. C. Vaughn, of the University of Michigan, from the liability of the fluid to develop the poison—tyrotoxicon—which is supposed to be the immediate cause of summer diarrhœa.

Professors Lachinof and Jerofeief have found in a meteoric stone which fell at Krasnoslobodsk, Russia, in September, 1886, corpuscles possessing the principal characteristics of the diamond, in such quantity as to compose one per cent of the stone. Taken with the facts that amorphous graphitic carbon is a known constituent of meteoric irons and stones, and that crystals of graphitic carbon have been found in the meteoric iron from Western Australia, this observation may throw some light on the manner in which diamonds are formed.

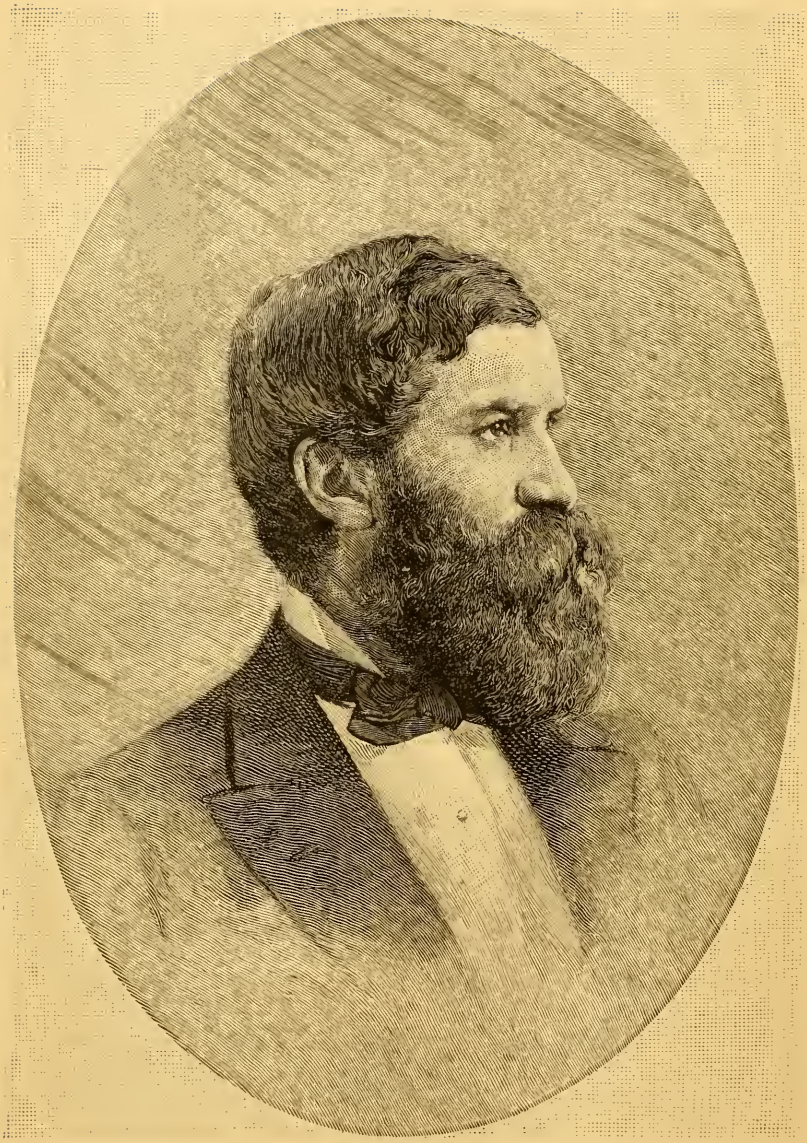
The much despised agricultural laborer, says the Earl of Derby, who has learned to watch and understand the signs of the weather, to be knowing about stock, and who can use his hands skillfully, though he might be backward in book-learning, is quite as well instructed in any worthy sense as the prize prig stuffed with scraps of miscellaneous information, but knowing little at first hand, unaccustomed to observe, ignorant of animals, trees, flowers, or country life, and unskilled in any craft or in the handling of any tool.

Dr. A. Richardson has found that at 500° C. nitrogen peroxide is decomposed into nitric oxide and oxygen, the gas becoming nearly colorless.

The theory that the increased brittleness of human bones with advancing years is the result of an increased percentage of inorganic salts, is contradicted by the experiments of Mr. Mason. From determinations of the ash in bones of fifty subjects of different ages, he has found that after reaching manhood no variation in the quantity of ash takes place with increasing age.

OBITUARY NOTE.

Prof. William D. Gunning, lecturer and writer on scientific subjects, died at Greeley, Col., March 8th, in the fifty-eighth year of his age. He was born in Bloomingburg, Ohio, in 1830, was graduated from Oberlin College, studied in comparative anatomy in New York and in biology with Prof Agassiz, held lectureships in geology at Hillsdale College, Mich., and in Pittsburg, and was the author of a "Life History of Our Planet." He was also a contributor to "The Index" and to "The Open Court," and at the time of his death had been engaged as the pastor of the Unitarian Society in Greeley.



ALPHEUS SPRING PACKARD.

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THE SURPLUS REVENUE.

By EDWARD ATKINSON.

IS the United States now in receipt of a revenue derived from taxation in excess of a reasonable expenditure for conducting the functions of the Government and meeting the current annual expenses of the nation, the pensions and other like obligations already incurred?

To this question a positive answer may be given. Yes. The surplus revenue of the United States, above the necessary expenses of the Government economically administered, is now at least $100,000,000 a year; and unless Congress at its present session takes some action for the reduction of the revenue, it may exceed ere long $150,000,000 each year.

On the other hand, it may be asked, Would a private corporation consider itself in possession of a surplus revenue from its business, which it would be at liberty to deal with at its own pleasure, *if* it owed a large sum of money on demand and a still larger sum of money subject to be paid on demand within a short period of time? No sound business man could be found who would affirm that under such conditions a private corporation could make any more suitable use of the revenue received in excess of its necessary expenditure than to apply it to the payment of its debt due on demand, and to prepare the way for making payment of the debt soon to become due at a date fixed.

If this reasoning be applied to the present condition of the United States, it will appear that the Government is *not* at the present time in the possession of a surplus revenue in any true sense. It owes on demand that sum of money which is represented by the evidences of debt, known as *legal-tender notes*, and commonly called *greenbacks*.

In order to be able to pay these notes on demand when demand is made, the treasury of the United States holds a special reserve of $100,000,000 in gold coin; but the amount of notes due is in round figures $350,000,000. The United States, therefore, owes substantially $250,000,000 on demand, for which it has as yet made no specific provision either in gold coin or to any considerable extent, even in silver coin which can be made available for such payments. The remainder of its gold held in the treasury above the special reserve of $100,000,000 is either subject to payment on demand in liquidation of gold certificates of deposits, or else it constitutes a part of the necessary daily balance of money necessary to the ordinary conduct of business. The larger part, if not the whole, of the silver dollars held by the treasury are held to meet the payment of the silver certificates which have been issued against them. There are, therefore, substantially $250,000,000 of United States notes due on demand, for which no specific provision has yet been made and to the payment of which the so-called surplus revenue could now be applied. Yet the public mind has become so accustomed to the common use of a debt currency, which under a fiction of law has been declared to be lawful money by the Supreme Court of the United States, as to have lost sight of the fact that the greenback or legal-tender note is not true money, but that it is an evidence of debt to be paid. Therefore, no consideration is given to the possible application of surplus revenue, so called, to such payment of these notes now due on demand.

In order that this subject may be made clear, it becomes necessary to recur once more to the original purpose of the Government in issuing United States notes and compelling their acceptance as lawful money by means of the legal-tender act. *These notes were issued in time of war for the purpose of collecting a forced loan and for no other purpose.* The necessity for a forced loan has ceased; the revenue of the Government is in excess of its necessary expenditures. When the revenue derived from taxation is paid to the Government in its own notes, that forced loan, to the amount of such notes paid in, has been liquidated by way of taxation. Each note returned to the treasury in settlement of a tax becomes like a common bank-note when redeemed by the bank; it is a note paid. It is *functus officio.* Its reissue by the treasury of the United States is in fact the collection of *a new forced loan* without authority of law under any act authorizing such a new loan, without necessity, without benefit to any one, and with positive danger to the whole community.

If the executive officers of the United States were to take the ground that these notes should not be reissued when they had once been paid into the treasury of the United States in settle-

ment of a tax, except under a specific act of Congress authorizing the collection of a new loan—i. e., without an act being now passed authorizing a new loan of money, for which purpose a specific act is required on the part of Congress under the existing statutes—could Congress itself compel the Executive to reissue these notes even as the laws now stand? Could Congress meet the case by a mere mandatory act, instructing the treasurer to reissue the notes, without passing an act for borrowing money or for negotiating a new loan on the terms named in these notes?

If not, then, so far as the excess of revenue received by the treasury of the United States over and above its necessary expenditures under the appropriations made by Congress consists of legal-tender notes, such notes cease to be money when they come back into the treasury. They no longer constitute a surplus; they are simply evidences of a demand debt which has been paid.

What objection is there to this course being taken? Simply this: Under a fiction of law, sustained by a decision of the Supreme Court, these evidences of debt have become a part of the circulating medium—i. e., a part of that which is used as money in that portion of the transactions of the people in which actual money is required; also, under the provisions of the bank act, these notes may constitute a part of the bank reserves held by them to meet their obligations when demand is made upon them for payment in money. Why should banks not be required to hold coin only for that purpose?

Upon what ground can a rich and prosperous nation hold to the belief that it can not afford to pay its debt due on demand lest it should be unable to supply itself with real money in place of this mock-money which has been forced into circulation under the stress of war and under an alleged necessity which has ceased? The instruments of exchange or currency which serve the purpose of money in the United States now consist of seven different kinds, viz., gold coin of full legal tender; Government certificates of gold coin; silver dollars of full legal tender; Government certificates payable in silver dollars; legal-tender notes redeemable on demand and receivable for taxes; national-bank notes convertible on demand into lawful money on presentation at the banks; subsidiary coin of limited legal tender.

The proportion of the transactions of the country in which actual money of either of these seven kinds is necessarily used, constitutes but a very small fraction of the transactions of all kinds. A vast proportion, far exceeding ninety per cent of all the transfers, bargains, sales of goods, stock, and real estate, are liquidated and settled by the use of checks, bills of exchange

and book accounts, without recourse to any actual money whatever. The money itself is used as an instrument only in the petty transactions of life. Yet such is the delusion regarding the necessity for a certain quantity of real or coined money, or for substitute money redeemable in coin, to be kept in actual circulation, that a panic nearly happened last summer because it was assumed that an undue proportion of these various kinds of money or currency would be called into the treasury and would not be reissued for lack of appropriations. Even the most sagacious bankers then appealed to the treasury for relief, as if this country did not hold a demand check upon the reserves of gold coin throughout the world sufficient to meet any such temporary difficulty! The panic was allayed, but allayed only by the very judicious action of the Treasury Department; but the cause of the panic was very soon *removed* by the import of over $30,000,000 in gold coin in response to our drafts during the summer and early autumn.

The whole volume of the coin of the world is at our disposal if we choose to draw upon it as we did last summer. If right consideration be given to existing conditions there could perhaps be no better use for the excess of revenue derived by Government from taxation than its application to the payment of that part of the demand debt, to wit, $250,000,000, which is not now covered by gold in the treasury. There could then be no objection to the continued circulation of United States notes in place of the coin itself; their form could be changed; they could be made into gold certificates corresponding to the silver certificates. Then the whole financial system of the country would be placed upon a solid foundation such as it had never before reached. If such a course were adopted, the excess of revenue over necessary expenses and probable appropriations by the present Congress would be likely to amount to about the sum of uncovered notes, viz., $250,000,000, in the interval between the present time and the time when the four and a half per cent bonds would become due and payable in 1891. Any excess of revenue at that time could then be applied to the payment of such four and a half per cent bonds. Is it not a financial absurdity to buy bonds not yet due at a high premium, and to make a forced loan by the issue of notes due on demand for that purpose?

It may, therefore, be time enough to shape legislation *on the mere ground of an alleged excess of revenue,* when the legal-tender notes and the four and a half per cent bonds shall all have been paid, and not before.

There may be other reasons for reducing taxation. The purpose of this memorandum is simply to treat the alleged excess of revenue and to show that there is as yet none above the positive

obligations of the Government which are due and payable. The purpose is to bring out the fact that there is a debt of the United States now due which can be paid; that the country is rich enough to pay it; that no financial disturbance would of necessity ensue; that the vast deposits of gold coin now held in Europe and our own annual product would suffice to meet our checks for $200,000,000, without serious embarrassment, to be used in the next two or three years, in liquidation of the balance due us for cotton, for corn, and for other commodities which the world must have and can not spare.

It therefore follows that if any temporary financial stringency should occur because of the withdrawal of the legal-tender notes from the bank reserves and from their use as money in this country, the burden or strain of that condition need not and would not be carried by the banks or bankers of this country, but would be transferred to our debtors who owe us, and will continue to owe us annually, on our merchandise account, more than we require to put ourselves on the most solid financial foundation of any nation in the world, viz., on a basis of a paper currency based upon actual bullion held in reserve, dollar for dollar. If it be said that such a demand for coin on the bank reserves of Europe would be met by a return of our securities, may it not be held that these securities are mostly held for investment, and that the more apparent the danger of war and of financial disturbance in Europe becomes, the larger will be the transfer of capital to this country for investment?

May it not be held that the very excess of revenue paid into the treasury over and above the necessities of the Government, is in itself a witness to the enormous financial power now held by the United States because of the very accumulation of capital which has occurred during the last few years? May we not be misled by a mere delusion in assuming that the legal-tender notes or greenbacks have any further useful function in this country if they ever had any?

When the fact is baldly stated which can not be denied, that the reissue of these notes from the treasury of the United States is not the continuance of a former loan, but is the actual borrowing of new money under a forced loan and in time of peace, can anything be more absurd than to assume that such a course is necessary? If the burden of taxation demands relief, that is altogether another matter. If, on the other hand, the burden of taxation is not serious, to what better purpose can the revenue be put than to the payment of any or all debts of the United States, to the end that, before the century is completed, the United States may be absolutely free from the debt which it incurred in order to maintain the integrity of the nation?

A COUNTER CRITICISM.

By HERBERT SPENCER.

WHILE I do not concur in sundry of the statements and conclusions contained in the article entitled "A Great Confession," contributed by the Duke of Argyll to the last number of this Review,* yet I am obliged to him for having raised afresh the question discussed in it. Though the injunction "Rest and be thankful," is one for which in many spheres much may be said—especially in the political, where undue restlessness is proving very mischievous—yet rest and be thankful is an injunction out of place in science. Unhappily, while politicians have not duly regarded it, it appears to have been taken to heart too much by naturalists; in so far, at least, as concerns the question of the origin of species.

The new biological othodoxy behaves just as the old biological orthodoxy did. In the days before Darwin, those who occupied themselves with the phenomena of life passed by with unobservant eyes the multitudinous facts which point to an evolutionary origin for plants and animals; and they turned deaf ears to those who insisted upon the significance of these facts. Now that they have come to believe in this evolutionary origin, and have at the same time accepted the hypothesis that natural selection has been the sole cause of the evolution, they are similarly unobservant of the multitudinous facts which can not rationally be ascribed to that cause; and turn deaf ears to those who would draw their attention to them. The attitude is the same; it is only the creed which has changed.

But, as above implied, though the protest of the Duke of Argyll against this attitude is quite justifiable, it seems to me that many of his statements cannot be sustained. Some of these concern me personally, and others are of impersonal concern. I propose to deal with them in the order in which they occur.

On page 144† the Duke of Argyll quotes me as omitting "for the present any consideration of a factor which may be distinguished as primordial"; and he represents me as implying by this "that Darwin's ultimate conception of some primordial 'breathing of the breath of life' is a conception which can only be omitted 'for the present.' Even had there been no other obvious interpretation, it would have been a somewhat rash assumption that this was my meaning when referring to an omit-

* See "Popular Science Monthly" for May, 1888.

† "Popular Science Monthly," vol. xxxiii, p. 57.

ted factor; and it is surprising that this assumption should have been made after reading the second of the two articles criticised, in which this factor omitted from the first is dealt with; this omitted third factor being the direct physico-chemical action of the medium on the organism. Such a thought as that which the Duke of Argyll ascribes to me, is so incongruous with the beliefs I have in many places expressed that the ascription of it never occurred to me as possible.

Lower down on the same page are some other sentences having personal implications, which I must dispose of before going into the general question. The Duke says "it is more than doubtful whether any value attaches to the new factor with which he [I] desires to supplement it" [natural selection]; and he thinks it "unaccountable" that I "should make so great a fuss about so small a matter as the effect of use and disuse of particular organs as a separate and a newly recognised factor in the development of varieties." I do not suppose that the Duke of Argyll intended to cast upon me the disagreeable imputation, that I claim as new that which all who are even slightly acquainted with the facts know to be anything rather than new. But his words certainly do this. How he should have thus written in spite of the extensive knowledge of the matter which he evidently has, and how he should have thus written in presence of the evidence contained in the articles he criticises, I cannot understand. Naturalists, and multitudes besides naturalists, know that the hypothesis which I am represented as putting forward as new is much older than the hypothesis of natural selection—goes back at least as far as Dr. Erasmus Darwin. My purpose was to bring into the foreground again a factor which has, I think, been of late years improperly ignored; to show that Mr. Darwin recognised this factor in an increasing degree as he grew older (by showing which I should have thought I sufficiently excluded the supposition that I brought it forward as new); to give further evidence that this factor is in operation; to show there are numerous phenomena which cannot be interpreted without it; and to argue that if proved operative in any cases, it may be inferred that it is operative on all structures having active functions.

Strangely enough, this passage in which I am represented as implying novelty in a doctrine which I have merely sought to emphasise and extend, is immediately succeeded by a passage in which the Duke of Argyll himself represents the doctrine as being familiar and well established:

> That organs thus enfeebled [i. e. by persistent disuse] are transmitted by inheritance to offspring in a like condition of functional and structural decline, is a correlated physiological doctrine not generally disputed. The converse case—

of increased strength and development arising out of the habitual and healthy use of special organs, and of the transmission of these to offspring—is a case illustrated by many examples in the breeding of domestic animals. I do not know to what else we can attribute the long slender legs and bodies of greyhounds so manifestly adapted to speed of foot, or the delicate powers of smell in pointers and setters, or a dozen cases of modified structure effected by artificial selection.

In none of the assertions contained in this passage can I agree. Had the inheritance of "functional and structural decline" been "not generally disputed," half my argument would have been needless; and had the inheritance of "increased strength and development" caused by use been recognised, as "illustrated by many examples," the other half of my argument would have been needless. But both are disputed; and, if not positively denied, are held to be unproved. Greyhounds and pointers do not yield valid evidence, because their peculiarities are more due to artificial selection than to any other cause. It may, indeed, be doubted whether greyhounds use their legs more than other dogs. Dogs of all kinds are daily in the habit of running about and chasing one another at the top of their speed—other dogs more frequently than greyhounds, which are not much given to play. The occasions on which greyhounds exercise their legs in chasing hares occupy but inconsiderable spaces in their lives, and can play but small parts in developing their legs. And then, how about their long heads and sharp noses? Are these developed by running? The structure of the greyhound is explicable as a result mainly of selection of variations occasionally arising from unknown causes; but it is inexplicable otherwise. Still more obviously invalid is the evidence said to be furnished by pointers and setters. How can these be said to exercise their organs of smell more than other dogs? Do not all dogs occupy themselves in sniffing about here and there all day long: tracing animals of their own kind and of other kinds? Instead of admitting that the olfactory sense is more exercised in pointers and setters than in other dogs, it might, contrariwise, be contended that it is exercised less; seeing that during the greater parts of their lives they are shut up in kennels where the variety of odors, on which to practise their noses, is but small. Clearly if breeders of sporting dogs have from early days habitually bred from those puppies of each litter which had the keenest noses (and it is undeniable that the puppies of each litter are made different from one another, as are the children in each human family, by unknown combinations of causes), then the existence of such remarkable powers in pointers and setters may be accounted for; while it is otherwise unaccountable. These instances, and many others such, I

should have gladly used in support of my argument had they been available; but unfortunately they are not.

On the next page of the Duke of Argyll's article (page 145), occurs a passage which I must quote at length before I can deal effectually with its various statements.* It runs as follows:

> But if natural selection is a mere phrase, vague enough and wide enough to cover any number of the physical causes concerned in ordinary generation, then the whole of Mr. Spencer's laborious argument in favor of his "other factor" becomes an argument worse than superfluous. It is wholly fallacious in assuming that this "factor" and "natural selection" are at all exclusive of, or even separate from, each other. The factor thus assumed to be new is simply one of the subordinate cases of heredity. But heredity is the central idea of natural selection. Therefore natural selection includes and covers all the causes which can possibly operate through inheritance. There is thus no difficulty whatever in referring it to the same one factor whose solitary dominion Mr. Spencer has plucked up courage to dispute. He will never succeed in shaking its dictatorship by such a small rebellion. His little contention is like some bit of Bumbledom setting up for Home Rule—some parochial vestry claiming independence of a universal empire. It pretends to set up for itself in some fragment of an idea. But here is not even a fragment to boast of or to stand up for. His new factor in organic evolution has neither independence nor novelty. Mr. Spencer is able to quote himself as having mentioned it in his *Principles of Biology*, published some twenty years ago; and by a careful ransacking of Darwin he shows that the idea was familiar to and admitted by him at least in his last edition of the *Origin of Species*. . . . Darwin was a man so much wiser than all his followers, &c.

Had there not been the Duke of Argyll's signature to the article, I could scarcely have believed that this passage was written by him. Remembering that on reading his article in the preceding number of this Review, I was struck by the extent of knowledge, clearness of discrimination, and power of exposition, displayed in it, I can scarcely understand how there has come from the same pen a passage in which none of these traits are exhibited. Even one wholly unacquainted with the subject may see in the last two sentences of the above extract, how strangely its propositions are strung together. While in the first of them I am represented as bringing forward a "new factor," I am in the second represented as saying that I mentioned it twenty years ago! In the same breath I am described as claiming it as new and asserting it as old! So, again, the uninstructed reader, on comparing the first words of the extract with the last, will be surprised on seeing in a scientific article statements so manifestly wanting in precision. If "natural selection is a mere phrase," how can Mr. Darwin, who thought it explained the origin of species, be regarded as wise? Surely it must be more than a mere phrase if it is the key to so many

* "Popular Science Monthly," vol. xxxiii, p. 58.

otherwise inexplicable facts. These examples of incongruous thoughts I give to prepare the way; and will now go on to examine the chief propositions which the quoted passage contains.

The Duke of Argyll says that "heredity is the central idea of natural selection." Now it would, I think, be concluded that those who possess the central idea of a thing have some consciousness of the thing. Yet men have possessed the idea of heredity for any number of generations and have been quite unconscious of natural selection. Clearly the statement is misleading. It might just as truly be said that the occurrence of structural variations in organisms is the central idea of natural selection. And it might just as truly be said that the action of external agencies in killing some individuals and fostering others is the central idea of natural selection. No such assertions are correct. The process has three factors—heredity, variation and external action—any one of which being absent the process ceases. The conception contains three corresponding ideas, and if any one be struck out the conception cannot be framed. No one of them is the central idea, but they are co-essential ideas.

From the erroneous belief that "heredity is the central idea of natural selection" the Duke of Argyle draws the conclusion, consequently erroneous, that "natural seclection includes and covers all the causes which can possibly operate through inheritance." Had he considered the cases which, in the *Principles of Biology*, I have cited to illustrate the inheritance of functionally-produced modifications, he would have seen that his inference is far from correct. I have instanced the decrease of the jaw among civilised men as a change of structure which cannot have been produced by the inheritance of spontaneous, or fortuitous, variations. That changes of structure arising from such variations may be maintained and increased in successive generations, it is needful that the individuals in whom they occur shall derive from them advantages in the struggle for existence—advantages, too, sufficiently great to aid their survival and multiplication in considerable degrees. But a decrease of jaw, reducing its weight by even an ounce (which would be a large variation), cannot, by either smaller weight carried or smaller nutrition required, have appreciably advantaged any person in the battle of life. Even supposing such diminution of jaw to be beneficial (and in the resulting decay of teeth it entails great evils), the benefit can hardly have been such as to increase the relative multiplication of families in which it occurred generation after generation. Unless it has done this, however, decreased size of the jaw cannot have been produced by the natural selection of favorable variations. How can it then have

been produced? Only by decreased function—by the habitual use of soft food, joined, possibly, with the disuse of the teeth as tools. And now mark that this cause operates upon all members of a society which falls into civilised habits. Generation after generation this decreased function changes its component families simultaneously. Natural selection does not cover the case at all—has nothing to do with it. And the like happens in multitudinous other cases. Every species spreading into a new habitat, coming in contact with new food, exposed to a different temperature, to a drier or moister air, to a more irregular surface, to a new soil, &c., has its members one and all subject to various changed actions, which influence its muscular, vascular, respiratory, digestive, and other systems of organs. If there is inheritance of functionally-produced modifications, then all its members will transmit the structural alterations wrought in them, and the species will change as a whole without the supplanting of some stocks by others. Doubtless in respect of certain changes natural selection will co-operate. If the species, being a predaceous one, is brought, by migration, into the presence of prey of greater speed than before; then, while all its members will have their limbs strengthened by extra action, those in whom this muscular adaptation is greatest will have their multiplication furthered; and inheritance of the functionally-increased structures will be aided, in successive generations, by survival of the fittest. But it cannot be so with the multitudinous minor changes entailed by the modified life. The majority of these must be of such relative unimportance that one of them cannot give to the individual in which it becomes most marked, advantages which predominate over kindred advantages gained by other individuals from other changes more favorably wrought in them. In respect to these, the inherited effects of use and disuse must accumulate independently of natural selection.

To make clear the relations of these two factors to one another and to heredity, let us take a case in which the operations of all three may be severally identified and distinguished.

Here is one of those persons, occasionally met with, who has an additional finger on each hand, and who, we will suppose, is a blacksmith. He is neither aided nor much hindered by these additional fingers; but, by constant use, he has greatly developed the muscles of his arm. To avoid a perturbing factor, we will assume that his wife, too, exercises her arms to an unusual degree: keeps a mangle, and has all the custom of the neighborhood. Such being the circumstances, let us ask what are the established facts, and what are the beliefs and disbeliefs of biologists.

The first fact is that this six-fingered blacksmith will be likely to transmit his peculiarity to some of his children; and some of these, again, to theirs. It is proved that, even in the absence of a like peculiarity in the other parent, this strange variation of structure (which we must ascribe to some fortuitous combination of causes) is often inherited for more than one generation. Now the causes which produce this persistent six-fingeredness are unquestionably causes which "operate through inheritance." The Duke of Argyll says that "natural selection includes and covers all the causes which can possibly operate through inheritance." How does it cover the causes which operate here? Natural selection never comes into play at all. There is no fostering of this peculiarity, since it does not help in the struggle for existence; and there is no reason to suppose it is such a hindrance in the struggle that those who have it disappear in consequence. It simply gets cancelled in the course of generations by the adverse influences of other stocks.

While biologists admit, or rather assert, that the peculiarity in the blacksmith's arm which was born with him is transmissible, they deny, or rather do not admit, that the other peculiarities of his arm, induced by daily labor—its large muscles and strengthened bones—are transmissible. They say that there is no proof. The Duke of Argyll thinks that the inheritance of organs enfeebled by disuse is "not generally disputed"; and he thinks there is clear proof that the converse change—increase of size consequent on use—is also inherited. But biologists dispute both of these alleged kinds of inheritance. If proof of this is wanted, it will be found in the proceedings at the last meeting of the British Association, in a paper entitled "Are Acquired Characters Hereditary?" by Professor Ray Lankester, and in the discussion raised by that paper. Had this form of inheritance been, as the Duke of Argyll says, "not generally disputed," I should not have written the first of the two articles he criticises.

But supposing it proved, as it may hereafter be, that such a functionally-produced change of structure as the blacksmith's arm shows us is transmissible, the persistent inheritance is again of a kind with which natural selection has nothing to do. If the greatly-strengthened arm enabled the blacksmith and his descendants, having like strengthened arms, to carry on the battle of life in a much more successful way than it was carried on by other men, survival of the fittest would ensure the maintenance and increase in this trait in successive generations. But the skill of the carpenter enables him to earn quite as much as his stronger neighbor. By the various arts he has been taught, the plumber gets as large a weekly wage. The small shopkeeper by his foresight in buying and prudence in selling, the village

schoolmaster by his knowledge, the farm-bailiff by his diligence and care, succeed in the struggle for existence equally well. The advantage of a strong arm does not predominate over the advantages which other men gain by their innate or acquired powers of other kinds; and therefore natural selection cannot operate so as to increase the trait. Before it can be increased, it is neutralised by the unions of those having it with those having other traits. To whatever extent, therefore, inheritance of this functionally-produced modification operates, it operates independently of natural selection.

One other point has to be noted—the relative importance of this factor. If additional developments of muscle may be transmitted; if, as Mr. Darwin held, there are various structural modifications caused by use and disuse which imply inheritance of this kind; if acquired characters are hereditary, as the Duke of Argyll believes;—then the area over which this factor of organic evolution operates is enormous. Not every muscle only, but every nerve and nerve-centre, every blood-vessel, every viscus, and nearly every bone, may be increased or decreased by its influence. Excepting parts which have passive functions, such as dermal appendages and the bones which form the skull, the implication is that nearly every organ in the body may be modified in successive generations by the augmented or diminished activity required of it; and, save in the few cases where the change caused is one which conduces to survival in a pre-eminent degree, will be thus modified independently of natural selection. Though this factor can operate but little in the vegetal world, and can play but a subordinate part in the lowest animal world; yet, seeing that all the active organs of all animals are subject to its influence, it has an immense sphere. The Duke of Argyll compares the claim made for this factor to "some bit of Bumbledom setting up for Home Rule—some parochial vestry claiming independence of a universal empire." But, far from this, the claim made for it is to an empire, less indeed than that of natural selection, and over a small part of which natural selection exercises concurrent power, but of which the independent part has an area that is immense.

It seems to me, then, that the Duke of Argyll is mistaken in four of the propositions contained in the passages I have quoted. The inheritance of acquired characters *is* disputed by biologists, though he thinks it is not. It is not true that "heredity is the central idea of natural selection." The statement that natural selection includes and covers all the causes which can possibly operate through inheritance, is quite erroneous. And if the inheritance of acquired characters is a factor at all, the dominion it rules over is not insignificant but vast.

Here I must break off, after dealing with a page and a half of the Duke of Argyll's article. A state of health which has prevented me from publishing anything since *The Factors of Organic Evolution,* now nearly two years ago, prevents me from carrying the matter further. Could I have pursued the argument it would, I believe, have been practicable to show that various other positions taken up by the Duke of Argyll do not admit of effectual defence. But whether or not this is probable, the reader must be left to judge for himself. On one further point only will I say a word; and this chiefly because, if I pass it by, a mistaken impression of a serious kind may be diffused. The Duke of Argyll represents me as "giving up" the "famous phrase" "survival of the fittest," and wishing "to abandon it." He does this because I have pointed out that its words have connotations against which we must be on our guard, if we would avoid certain distortions of thought. With equal propriety he might say that an astronomer abandons the statement that the planets move in elliptic orbits, because he warns his readers that in the heavens there exist no such things as orbits, but that the planets sweep on through a pathless void, in directions perpetually changed by gravitation.

I regret that I should have had thus to dissent so entirely from various of the statements made and conclusions drawn by the Duke of Argyll, because, as I have already implied, I think he has done good service by raising afresh the question he has dealt with. Though the advantages which he hopes may result from the discussion are widely unlike the advantages which I hope may result from it, yet we agree in the belief that advantages may be looked for. How profound and wide-spreading are the consequences which may follow from the answer given to the question—"Are acquired characters hereditary?" I have pointed out in the preface to *The Factors of Organic Evolution* in its republished form; and perhaps I may be excused if I here reproduce the essential passages for the purpose of giving to them a wider diffusion:

"Though mental phenomena of many kinds, and especially of the simpler kinds, are explicable only as resulting from the natural selection of favorable variations; yet there are, I believe, still more numerous mental phenomena, including all those of any considerable complexity, which cannot be explained otherwise than as results of the inheritance of functionally-produced modifications. . . .

"Of course there are involved the conceptions we form of the genesis and nature of our higher emotions; and, by implication, the conceptions we form of our moral intuitions. . . .

"That our sociological beliefs must also be profoundly affected

by the conclusions we draw on this point, is obvious. If a nation is modified *en masse* by transmission of the effects produced on the natures of its members by those modes of daily activity which its institutions and circumstances involve; then we must infer that such institutions and circumstances mould its members far more rapidly and comprehensively than they can do if the sole cause of adaptation to them is the more frequent survival of individuals who happen to have varied in favorable ways.

"I will add only that, considering the width and depth of the effects which acceptance of one or other of these hypotheses must have on our views of Life, Mind, Morals, and Politics, the question—Which of them is true? demands, beyond all other questions whatever, the attention of scientific men."—*Nineteenth Century.*

THE PHILOSOPHY OF COMMERCIAL DEPRESSION.

By H. G. S. NOBLE.

IN seeking the explanation of highly complex phenomena, many simple and entirely inadequate causes are apt to be assigned by men who have become absorbed in them to the exclusion of other factors; and an ultimate comprehension of the problem is usually reached when some wide generalization, including many single causes, is found.

Thus, to account for the recurring waves of commercial depression to which the modern world is a prey, the bimetallist, the protectionist, the free-trader, and other specialists, urge their pet theories as individually sufficient; while in some far-reaching chain of influences, of which these are but necessary links, is probably to be found the complete cause. What follows is as much of an attempt as so brief a space will permit to find for these phenomena a generalization of this kind.

Life, or in more general terms the persistence of any organic aggregate, depends upon adaptation to surrounding circumstances. In the animal creation this adaptation is of two fundamental descriptions: first, the development of structures for the assimilation of nutriment; and, secondly, the development of structures for the obtainment of nutriment in competition with other organisms.

In the physical struggle, which grew more intense with the multiplication of organic forms, this second mode of adaptation reached its culmination in man. Indirectly, through the use of a more developed brain, the human being so employed the forces of Nature as to overcome the teeth and claws and brawn of his

animal rivals, and command the life-supporting products of the earth. These transcendent powers, by which the brute creation had been subjugated, men soon turned against each other, and the battle of life between man and man became as terrible as that between man and beast. But, unlike the fierce predatory mammals and the antediluvian monsters over which he had triumphed, the human animal soon ceased to carry on an isolated, individual, effort of self-preservation. Out of the early sexual association of mating, which he developed in common with many other creatures, there sprang the family, the tribe, and finally the nation. Co-operative organization was begun, from which has grown what we call civilized life.

The first grouping of many individuals into a tribe was the birth into the world of a new organism. This new organism has in the course of ages so grown, and developed, and differentiated in the complexity of its functions and structures, that it is recognized by modern philosophy; and the dawning study of the laws under which it lives constitutes the infant science of sociology.

We can not stop here to demonstrate this assertion, which the advanced thought of to-day has accepted and which the world at large is coming more and more to understand, that society, like the individuals of which it is made up, is an organism living by constant adaptation to its environment. To those who deny this, no inquiry into the main topic of our discussion is possible. Assuming it, therefore, to be a necessary postulate to all economic study, let us proceed to examine the character of that organism at the earliest stage of its growth.

The prehistoric human being, or unit with which the social structure was built, must have been, from our nineteenth-century standpoint, near akin to the brutes in the savageness of his instincts. Bred to a life of peril and physical conflict, the aggressive and predatory in his nature must have far exceeded any germs of those gentler attributes at present thought to be distinctively human. Now, as the nature of any whole must be determined by the aggregate natures of its component parts, the superorganic whole which the combination of these earlier individuals created must have displayed in a general way their common traits. In a word, the early tribe or germinal society was an aggressive, predatory organism, striving to perpetuate itself by the annihilation of all similar organisms with which it came into competition.

Why this fact is of importance to our discussion we can at once show. If all organisms perpetuate themselves by the adaptation of their structures to the particular circumstances of their lives, then a knowledge of these circumstances must be a key

to the structural peculiarities of any given organism. It follows, therefore, that if the earliest human societies lived, like the animal creation from which they were evolved, by an aggressive struggle with their neighbors, the fundamental social structure must have been one adapted to war.

Let us see if this is not the fact.

The first differentiation traceable in the savage tribes of all times is the rise to power of the strongest or ablest individual of the group, and the growing subordination to his authority of his followers. Along with this is traceable that change in the primitive instincts by which the individual energies are directed to the tribal, rather than the individual welfare, and the latter is in a degree sacrificed to the general good—the germ, in fact, of what we now call patriotism. What advantage to the tribe these changes involve hardly needs stating. Complete subordination to a directing head, like the rapidly co-ordinated muscular actions of a fighting animal, is an absolute necessity to the warlike success of a co-operating group of men. And the willingness of each individual to value the general triumph above his own safety, is no less important to the same end. Out of these two earliest structural adaptations there have grown, in the course of social evolution, a vast complexity of others based upon them, and tending to the successful performance of the same great function—the prosecution of war.

For the elaboration of this truth we refer all who may be skeptical to Herbert Spencer's discussion of the "Militant Type of Society." It suffices for our purpose to point out that this "militant type" is the one in which social organization begins.

In pursuing the ends of early militancy, the active brain of man struck upon a course which has forever lifted him above all other living things, the use and adaptation of external forces for the furtherance of human ends. With the first weapon fashioned by some prehistoric warrior was opened a new field for the exercise of human energy. Work for the purpose of creating was initialed in contrast to the destructive activities of the animal world. Step by step expanding intelligence led the labor of brain and hand first to producing appliances for war, the prosecution of which against both man and beast was necessary to the support of life, and then to supporting life directly by the creation from natural sources of its requirements. To manufacture for man's wants out of Nature's resources began to take the place of a mere sanguinary struggle over her raw materials.

Labor became a partial substitute for fighting.

It needs no demonstration that this new use of the energies had nothing in common with the earlier animal instincts from which the militant social structure evolved. What, then, could

be more natural than to find that, with its growth, a structural readaptation of the social organism has been taking place? Such a readaptation has been, and is, in constant progress; and the great authority, to whom we have above referred, traces out, under the title "Industrial Type of Society," the character and tendencies of the structures it is producing.

Thus, starting with the dictum of modern sociology that society is an organism living by constant adaptation to surrounding conditions, we find that its earliest structure is the "militant," fitting it for the predatory life of war; and that a new structure, suited to living by the fruits of productive labor, is being constantly developed by it. Let us briefly contrast these two social structures as they appear in our highly evolved life of to-day.

"Militancy," as is shown in its early development of a chief or tribal leader, entails, above all, autocratic government. A nation, to fight well, must act under one centralized control. It necessitates, furthermore, the existence of the individual for the benefit of the state; as, the more complete the subordination of the part to the whole becomes, the more will the combined energies be concentrated for national ends, and freed from waste in the direction of mere personal requirements. In its completeness, "militancy" means the absolute monarch ruling unquestioning subjects; the development of tyranny in the superior, slavishness in the subordinate, and all those harder and more savage traits which are best suited to the needs of war. It means the worship of might, and the creation of rigid social classes based upon it, such as survive even to-day in the aristocracies of civilized Europe. If "militancy" could be complete in its sway, the word "freedom" would not exist in language, for freedom denotes the assertion of individuality, and "militancy" the merging of all individualities save those of rulers. In a word, society under unqualified "militancy" is very naturally best typified by an army and the system which governs it.

What under this *régime* would be meant by the word prosperity? When is a militant society prosperous? Obviously, when the end for the achievement of which its structure has been evolved is completely attained; or, to specify, when the maintenance of the lives of its component individuals has been assured by the forcible destruction of competitors, and the acquisition by capture of all coveted fruits of the earth.

To illustrate by an example: Rome was a community in which the militant organization immensely predominated, and whose unchallenged mastery of the ancient world justifies, as applied to her condition, the word prosperous. This prosperity was achieved through the gradual acquisition, by force of arms, of nearly all the territory of the known world; through an en-

slavement and absorption of rival communities analogous to the assimilation of food by an animal organism; and, in fine, through a literal devouring of all the social organisms in her environment, which lasted until, like a great parent-cell, she burst into the many smaller cells that constitute the nations of modern Europe.

Turning to "industrialism," as its distinctive features are beginning to show themselves in our modern civilization, we find tendencies almost directly opposite. To begin with, the effort to sustain life by productive labor requires, for its success, that the best energies of each individual should be concentrated on the particular work his capabilities fit him for, and taxed as little as possible by the requirements of society as a whole. Every man must be left to develop himself to the utmost, as the total product of the labor of all can only increase with the efficiency of each. This necessity is soon rendered still more imperative by that early differentiation in industrial organization which localizes the production of different forms of commodities, and leads to barter; for only in the absence of the capricious meddling of authority can producers of one commodity measure the permanent value of their work in relation to the products of others. Furthermore, that a strong enough motive for the greatest individual exertions may ever exist, the returns of labor must be proportioned to energy expended; and this they never can be when the natural working of cause and effect is set aside by the artificial action of government. The outcome of these facts is the assertion of freedom; the belief, exactly opposed to that of "militancy," that the state exists for the benefit of the individual, and the consequent tending toward popular government.

"Militancy," then, sacrifices the individual to state-preservation. "Industrialism" uses the state as a means to individual betterment. Growing "militancy" produces concentration and increase of governmental power; restriction of the larger human sympathies involved by national enmities; rigidity of class distinctions, and subordination to authority. With growing "industrialism" the sphere of governmental control diminishes; its hold upon individual freedom is relaxed; the common brotherhood of man grows with the intermingling of commercial life, and the class distinctions built up by brute force melt away in the competition of productive energy. The community lives by the separate activities of its units carried on for personal ends, and unimpeded by the unnecessary meddling of central authority. That prosperity under this *régime*, in its completeness, differs from the prosperity of "militancy," above defined, as daylight from darkness, a moment's contemplation of it will show.

In order to insure it, the aggregated toil of the earth's inhabitants would be left to produce from the soil all the needs of human life. Unhampered by artificial restrictions, and untaxed by waste or destruction, the wealth so produced would more than suffice for this end. Its distribution, left to the natural laws of competition and of supply and demand, would be such that the greatest energy and skill expended would bring the greatest returns; and men would obtain of the world's goods according to their deserts. The prosperity of "industrialism" in its perfection would be but another name for the millennium, when all men would toil in common brotherhood, and each take from the store of wealth produced the equivalent of the work he contributed.

A wide and all-pervading difference thus exists between these types of structure into which the social organism tends to grow, showing itself especially in the utterly unlike conditions each requires to realize prosperity. That they are at variance, and must strive to displace each other wherever they coexist, is too obvious a corollary to need verification. How this fact points to a true conception of the philosophy of commercial depression, let us now see.

A universal law of social progress, with which we are all familiar, is that established systems in thought, morals, manners, government, or any department of human activity, struggle to perpetuate themselves by a fight against all innovations. Whatever is new and progressive, or represents the requirements of an enlarging field of life, has got to gain its foothold in the face of the powerful opposition of the old and pre-established. Those more perfected and exact conceptions of Nature, which we call scientific ideas, have prevailed only after centuries of mortal strife with the inherited superstitions and imperfect generalizations of our semi-civilized forefathers. The progressive and liberal governments of our most advanced nations to-day have been established in spite of the bitter opposition of their predecessors, and are themselves fighting tooth and nail the higher forms that will succeed them. In literature and art old schools strive to deny existence to the new; and, even in the little affairs of our daily lives, we are all permitting the things that are, and "have sufficed to our fathers before us," to keep out the better things that might be.

The result of this universal war between the old forms and the new is, to the former, ultimate change or destruction; while to the latter—and here is the vital point of what we are trying to demonstrate—it is constant *retardation.*

Every triumph of superstitious ignorance *retards* the harmonious spread of science; every point gained by the political

conservative is a set-back and a hindrance to the attainment of the liberal's greatest ends; and so on, throughout human affairs, is there a check—beneficial in its regulative influence, but still a check—to progress.

Now, what are these substitutions of science, in our knowledge of men and things, for a relative ignorance? Of the newer and better for the old and worn-out in political institutions? Of the new art and literature of broader life for that which stood for simpler feelings and ideas? Of the future of all things human for their past? They are simply the details of the one all-including change by which the social organism is passing from "militancy" into "industrialism." That change in which the life of destructive violence, inherited from the brute creation, is giving place to the life of productive labor we call civilization. And, if what is true of these details is true, as it must be, of their collective sum, then the evolution of "industrialism" is constantly suffering *retardation* from the persistence of established "militancy."

This is the generalization at which we aimed. Commercial depression is due to the retardation of industrial growth produced by the survival of militant organization.

There is but one test for the validity of all theories, and that is their application to the facts of which they treat. To fulfill this test in the case before us, let us turn our attention to Europe, whence the cry of commercial depression has for some years been exceptionally acute.

We find there an armed camp of nations in constant readiness for war; the fruits of the tireless labors of the people drawn off for the nourishment and support of ever-increasing military organization, so that every year turns what should be the reward of growing wealth into accumulating public debt; militancy in the prepondering forms of government; militancy in international relations, successful militancy the ruling ambition at the sacrifice of all industrial aims! But, bear in mind, it is no longer militancy in its prime—like that of Macedonia or Rome. It is modern militancy, riddled through and rotted at the core by civilization. Not one of the great nations, wasting its substance in the costly armament of war, can ever get a return on the fatal investment. The day for enslaving neighboring states and living on the fruits of battle is past. Every costly struggle of the century has left the combatants poorer and retarded their growth. Where are the fruits, to the prosperity of France, of Napoleon's fabulous conquests? to England, of the Crimean war? to Germany, of the war of 1870? to Russia, of her struggle with the Turk? Not one of the parties to these wars has fattened on the spoils of the enemy, and all have been joint losers

in the wealth destroyed. How clear, then, is the source of commercial distress! The machinery of war, which can no longer be made profitable, exhausts, in its unnecessary perpetuation, what ought to be the surplus of production. It has become a system of disbursements without counterbalancing receipts, producing scarcity and want.

With what state of facts could our theory more exactly correspond? Is not the condition one where surviving "militancy" is impeding that "industrial" growth in which alone civilized prosperity can be found? Then the only remedy for European poverty and distress is plain. The disappearance of autocratic governments, the disbandment of armies, the repeal of artificial restrictions on trade imposed to raise the revenues of war; in a word, the removal of all that has its roots in "militancy." Slowly, indeed, will this great, far-reaching change come about, but with it alone can the growth of what we call prosperity proceed.

Leaving warlike Europe, and turning home to our own great, peaceful, and hard-working commonwealth, it would seem that "industrialism" being so manifestly the type of American civilization, the existence of commercial depression with us affords evidences fatal to the theory we have been elaborating. How, if this theory be sound, can a land of peace and free government ever be the scene of "hard times"?

First, as a partial substantiation of our position, we would point to the familiar fact that the accompaniment of the predominating "industrialism" of the United States has been a growth of wealth and prosperity far exceeding in rapidity that of any other historic people. All that remains for us to show, therefore, is that the interruptions to this prosperity are to be traced to militant tendencies.

There are two great issues before the American people to-day, in the settlement of which, all are agreed, the national welfare is deeply involved. These are the tariff and the currency issues. Let us inquire into their nature. Institutions, like men, may largely be judged by their genealogy; so let us ask whence came this system of enormous taxes upon imports, the wisdom of which men view so differently. We find it had its birth in the necessities of war. True, the representatives of a number of wealthy industries, which have fattened at the public expense under this artificial barrier to competition, would have us believe that the function of a tariff is to start a nation into industrial activity —the extraordinary implication being that industrial activity would not arise independently of such a device; but of the almost impassable barrier, which confines our commerce to-day, war alone was the creator. To the philosophic observer, then,

the tariff can yield but one interpretation: It is a militant appliance for raising money, which has been continued in existence after militant necessities have ceased; and our surplus revenue, drained from the labors of the people and poured into a treasury that has no outlet for it, fitly symbolized its uselessness and waste.

But how about the belief, ever rising to the surface of our political whirlpool, which, in its extreme shape, advocates printed pieces of paper as a medium of exchange; and to-day, in a modified form, urges the use of a silver coin of less than its pretended value? Was it in the slow experience of peaceful commerce that men first detected the supposed benefits of fictitious money? Did the developing needs of industrial life lead to its use? No. Again war was the parent. War, destroying more wealth than the savings of a community could be drawn upon to supply, mortgaged the future with a promissory note; and the mental weakness of many men, which incapacitates them from perceiving the necessary equivalence between a cause and its ultimate effect—from knowing that, in some form or other, every debt incurred must ultimately be met—deludes them into the belief that this note can pass current forever.

Twenty-seven years ago a reversion to militancy was forced upon us by our cruel civil war, which, like a disease, left its deadly taint in the body politic to linger on until to-day. In spite of the enormous growth that our vast territory, our active and laborious population, and the never-ceasing stream of immigration have rendered possible; in spite of conditions for wealth and plenty such as no people ever knew before—through the major part of these twenty years has been felt the influence of some vague deterrent to the completeness of prosperity, and the complaint of trade depression has been almost constant throughout the land. Militant forms, surviving in the tariff and dishonest money, will in time be recognized as the efficient causes of this state of things.

If what we have said stands for a real truth; and if the general underlying cause of all commercial reactions is to be found in the protracted life of a system that society has outgrown, which checks the growth of one more suited to its needs—the realization of the fact can not fail to be of value. All legislation, based on such knowledge, would proceed in the line of real commercial advantage; and a test by which to judge the fitness of new measures for the needs of modern life would be supplied. Lest this should seem too visionary, we shall close with an illustration of its possibilities.

The community to-day is deeply moved by a new disorder of the social organism known as the "labor problem." The lower

classes, or those who are more distinctly physical as opposed to mental laborers, are striving to offset the corruption and abuses of the very wealthy by a system of organized aggressive action. They have accomplished nothing, so far, but harm to themselves, and diffused disturbance to the great mechanism of trade through which the entire people live. The generalization we have tried to establish furnishes the key to this difficulty.

The interest of the "laboring class" so called, as well as of the whole community in America, is purely industrial. The laborers are the product and symbol of industrial growth. No good, therefore, can be worked for them save through industrial appliances. Now, if we inquire into the character of the organization known as the "Knights of Labor," we find it to be as purely militant as the name it bears. It displays absolute autocracy of government; complete loss of individual freedom; the gospel of class hatred and strife preached in the place of the co-operation and sympathy of "industrialism"; and, finally, the natural outcome of all militant tendencies, a resort to physical violence for the attainment of ends. The "Knights of Labor" are a militant organization applying militant means to the betterment of industrial conditions. What wonder that they fail?

And, withal, the industrial means to the attainment of all legitimate ends that they may seek are ever at their disposal. What abuses could the rich few perpetuate in free America, if the poor many chose to use the ballot-box to crush them out? None. And if, as appears to be the case, it is a grievance that the able and hard-working triumph over the foolish and lazy in the struggle of life, the reconstitution of man, not of society, will alone remedy it. Is there not here a hint for Messrs. Powderly and George?

In an essay on "The Swarming of Men," Mr. Edward Courtney assumes that emigration is controlled by a force which operates as strongly and uniformly as any natural law. By it, whenever men find it too hard to make a living, they are induced to move themselves away, either to places within their own country where work is more plentiful, or to places beyond the sea. "An examination of true centers of life," he says, "leads us inevitably to connect the shifting points of maximum increase with the development of some industry, the discovery of some local springs of activity, a new appreciation of previously unrecognized facilities for the application of more efficient processes of labor. Some change makes it possible for more life to be sustained at a given spot, or to be more favorably sustained than elsewhere, and immediately more life appears there."

WHISTLES ANCIENT AND MODERN.

By M. L. GUTODE.

NO instrument, probably, has been invested with more various forms than the whistle. It would take a volume to present properly all of these forms and their passages from one to another, which I have no intention of doing. I aim only to distinguish a few points that may indicate to others how extensive a field there is into which they may explore if they will. The primary idea of a whistle lies in the making of a column of air to vibrate, in whatever condition. As there is no lack of means or methods for doing this, the infinite diversity of the forms of the apparatus for producing the vibrations and the resultant sounds is a matter of course. The most general form is the human whistle, which one can make sound—after a fashion—without much preliminary training; but many musicians have made themselves masters of its intonations to such a degree that, instead of the usual inharmonious and unmethodical discords, they can render with it the most difficult passages of elaborate musical compositions. I shall not dwell upon the means that may be employed to make the sounds sharper and to modulate their tones. Every one knows what effects are produced by inserting the fore and second fingers so as to turn the tongue slightly back as the column of air passes over it, or by sending the blast over the outside of the bent fingers.

If we seek other primitive whistles, we have them in the hollow-barreled key, the terror of authors and comedians; the famous willow whistle, cut when the twig is most sappy; the green dandelion stem, split along its length; the nut-shell between the fingers; the cherry-stone, which school-boys grind down so patiently on the soles of their shoes and perforate; the buck-horn, and all the other things which we are fond of contriving, in our early youth, with which to split the ears of parents and teachers.

Seeing that so much can be done with such rude means, it is not strange that the whistle was a well-known instrument in antiquity. The old Peruvians were past masters in the fabrication of whistles. They made them in great numbers, of earth, and ornamented with various designs and figures of animals. The porcelain-factory at Sèvres (Fig. 1) possesses two specimens of their workmanship, one of which resembles a nightingale; and, when filled with water, it produces a kind of warbling. There is an instrumental museum at the Paris Conservatory of Music, which is open to the public on Thursday afternoons. It was

founded by Clapisson, and in the beginning consisted only of a single collection—of whistles. This was, moreover, a most curious collection, comprising whistles of all ages and all countries, of terra-cotta, copper, ivory, hard stone, etc., some of which were

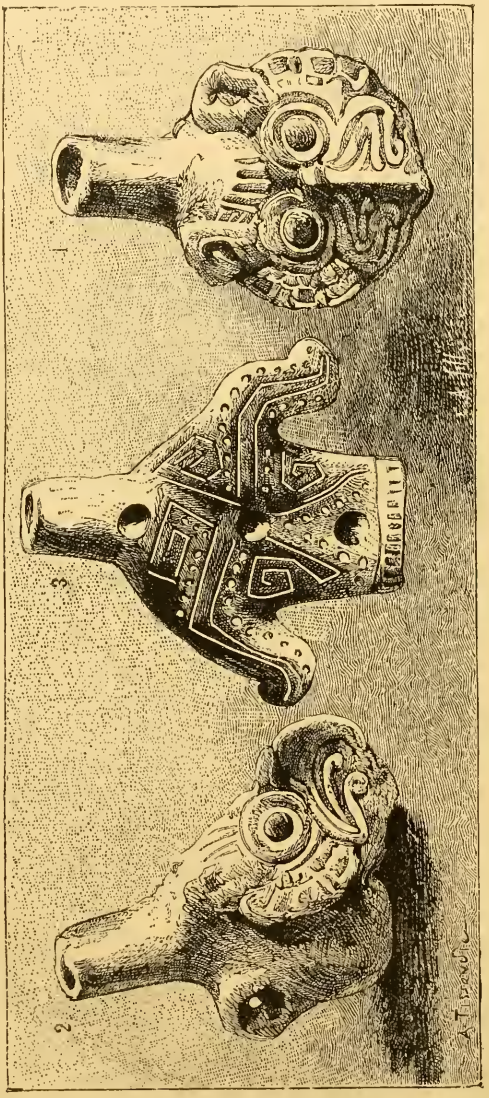

Fig. 1.—Ancient Peruvian Earthen Whistles. Nos. 1 and 2, figure of an animal, in face and in profile. No. 3, another form. (From specimens in the Sèvres Museum.)

remarkable as specimens of invention and workmanship. Unfortunately, this collection was scattered to the winds at an auction-sale twenty years ago, and the conservatory has not preserved any part of it; but there are still a great many curiosities in the instrumental museum—serpents in the most distressing shapes,

horns and trumpets of crystal, flutes of porcelain, fiddles of faience, Alpine horns, a bassoon of such extraordinary adjustment that it is a day's work to dismount it; and many other most curious contrivances for producing melodies and accompaniments.

One of the most simple whistles, most closely approaching the theoretical form, is the American, or secret whistle (Fig. 2), which is composed of a strip of metal bent over, one end of which, A, is cut beveled, and is placed opposite the opening of the hollow box *o o'*. Apply the mouth and blow at *o*—no sound is produced; and in this lies the secret of the instrument. But on closing the open ring T with the thumb and forefinger, a vigorous whistling sound is obtained, the intensity of which may be modified by raising or lowering the bevel, A, so as to bring it nearer to or farther away from the box *o o'*.

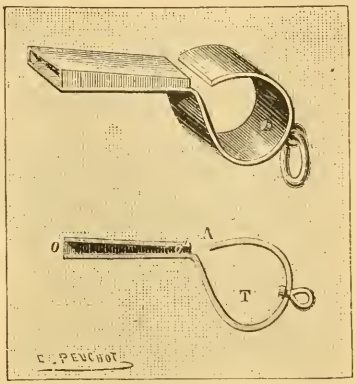

Fig. 2.—Secret Whistle. Outer View and Section.

A pen and pencil-case whistle, with which dealers in holiday toys have had considerable success, deserves to be mentioned here. It is an ordinary whistle at the end of a tube, in which a solid cylinder is moved so as to modify at the will of the performer the length of the column of vibrating air. Persons skilled in using it are able to play a considerable variety of simple tunes upon it. Among the whistles that give out several notes, we

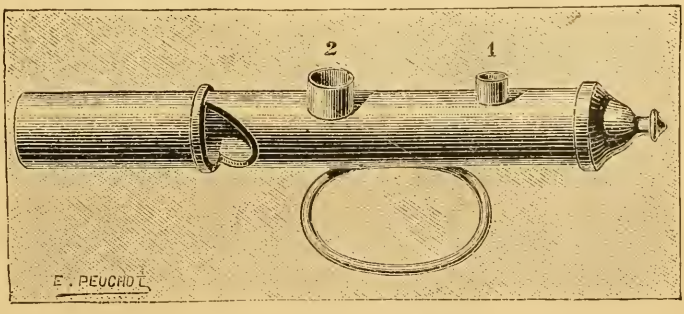

Fig. 3.—Commandant's Whistle.

also cite the commandant's whistle (Fig. 3), which, besides its mouth, has two openings that are controlled by the fore and middle fingers. With both holes closed, it gives the note *sol*; with hole No. 1 open, *do*; and with both holes open, *mi*.

We might make a distinct and legitimate study of numerous forms of sounding apparatus, constructed on the theory of the whistle, whose peculiarities consist in the manner in which the air is sent over the tongue, the vibration of which produces the sound. Thus, we have the pedal-horn, and the India-rubber bulb whistle of tramways and omnibuses, the various systems of horns that give notice of the approach of fire-engines, the alarm whistles of steam-engines, "howler" whistles, and locomotive whistles; the last of which are sometimes tuned to nearly a distinct tone for each line. Much that is interesting might also be said concerning the variations in the engineer's whistle for his different calls, upon the signal-man, for the clearance of the track, etc. But this would take us away from our topic.

Modern common whistles are infinite in their variety, and new kinds are appearing every day, as the fancies of amateurs bring them forth. They are made of wood, bark, metal, horn, shell, glass, and even of sugar. While the form of the apparatus and the manner of using it change from time to time, as the fruitful imaginations of fanciers devise new patterns, the principle of the construction is invariable. Some conception of the capabilities in design of the instrument may be gained from a glance at Fig. 4. Among the whistles here represented, we find the scholar whistle (3), the fireman's whistle (5), which gives *mi* when the upper hole is open, and *do* when it is closed with the finger; the Belgian whistle (15), of inelegant shape; the square whistle with two holes, giving two notes (7); and the Baduel army regulation whistle (9). Of a quite different type is the Swiss whistle for railroad-station agents (2), in which the column of air is broken upon the summit sphere and a part is swallowed up, while another part is thrown outside. The marine regulation whistle (6) is of a similar structure; but, like the American whistle, there is a secret in manipulating it. In order to produce a sound, the upper end of the pipe and the adjacent sphere must be shut up in the hand. A variety of movements are necessary for the execution of different modulations, which make a whistling-school on the quarter-deck the analogue of the schools of the trumpet and the drum in regiments. There are also whistles with three or four openings, like the horn whistle and the railroad whistle. In the former (12) the extremities A and D may be regarded as mouths, and the sounds are also modified by closing alternately or in succession the openings B and C. In the second (13), by leaving all open, we obtain a quite characteristic mixed and false sound. Special modifications are obtained with the roulette whistle (1) and the bird whistle, with which the songs of various birds are imitated. Fancy has run rife in devising typical whistles, like

the dog's-head whistle (10) for hunters, and many-ended whistles, like the army whistle with compass (11), the match-box whistle

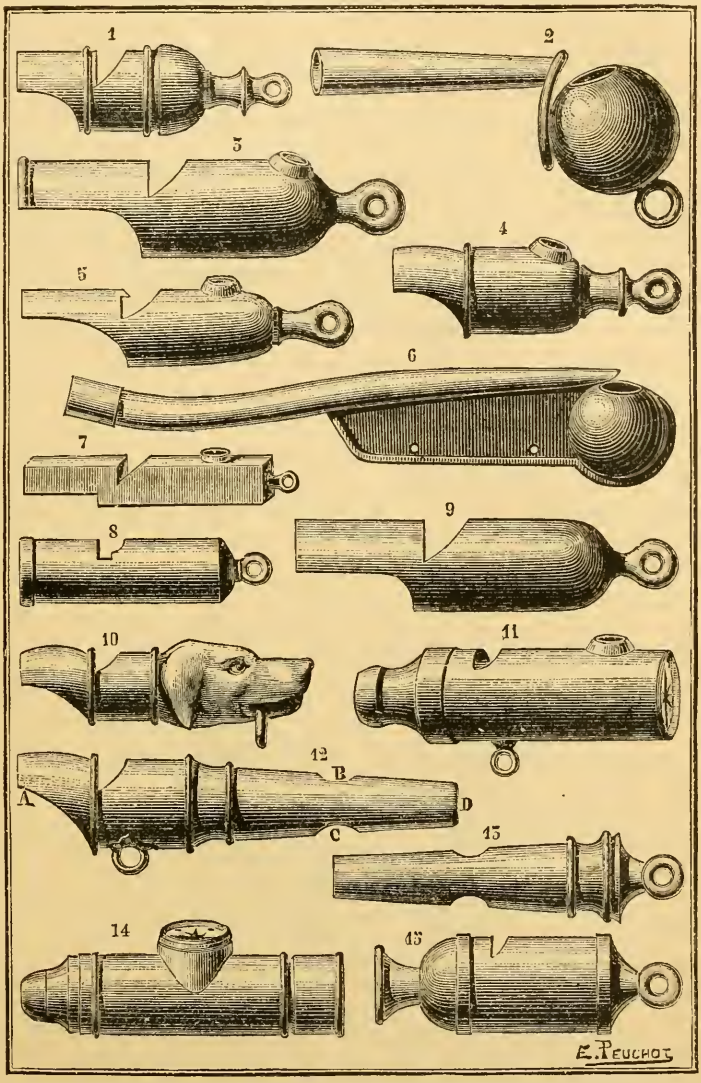

Fig. 4.—Different Kinds of Whistles. 1. Roulette whistle. 2. Swiss railroad-station agent's whistle. 3. Scholar whistle. 4. Another type of the same. 5. Fireman's whistle. 6. Marine regulation whistle. 7. Square whistle with two holes. 8. Round whistle. 9. Army regulation whistle. 10. Dog's-head whistle. 11. Army compass whistle. 12. Whistle and horn of three notes. 13. Railroad whistle. 14. Match-box and compass whistle. 15. Belgian whistle.

(14), cigarette-case whistles, whistling canes, whistling hunting-whips, whistling sleeve-buttons, etc.

Among the matters to be taken into account in the making of whistles are the effect of the length and the diameter of the

tube, the width of the mouth-piece and its length, the size and thickness of the tongue, the diameter of the instrument, the size of the orifice, the nature of the material of which it is composed, etc., variations in any of which produce—sometimes very important—modulations in its tone. Experiments have shown that *do* and *mi* in particular have a round, full, well-supported sound, which in the Baduel regulation whistle can be heard for a distance of more than six hundred metres.

Competent observers have asserted that the manner of whistling is not always the same, and that there are some unhappy persons who can not whistle at all. According to these authorities, among whom is M. Baduel, to whistle well it is necessary to pronounce *tu . . . tu* slowly; then *tu . . . tu . . . tu* more and more rapidly and quite distinctly, especially taking care not to whistle from the throat. To make the double tongue-stroke, we must say *tu . . . du . . . g, du,* to give the trill; but we should always begin slowly, and proceed gradually to greater rapidity.

Correspondents of "La Nature" have sent in to it illustrations and descriptions of other whistles than those which M. Gutode describes. One of them is a terra-cotta bird-shaped whistle, somewhat like the Peruvian whistles, which has been recovered from the prehistoric relics near Florence (Fig. 5). The

Fig. 5.—Earthen Whistle from near Florence.

sound is produced by blowing into the bird's beak. Another, an extremely simple form, is used by the foremen in the spinneries of northern Europe, to direct the changing of the bobbins on the looms. It is made of tin (Fig. 6), and gives out a sound

strong enough to overcome all the other noises in the shop, while it is also susceptible of musical modulations. But there is a special art in sounding it. The tongue must be brought up to the hole in the upper blade without stopping it, and the air must be projected simultaneously through both holes, so as to

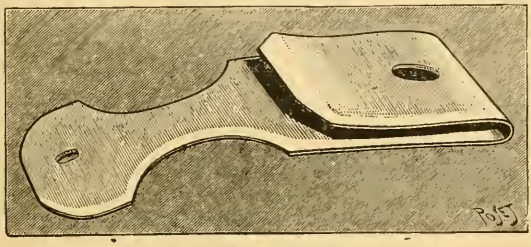

Fig. 6.—Spinner's Whistle.

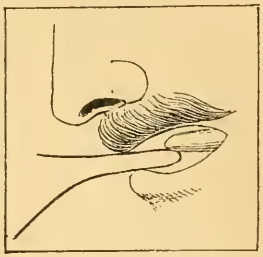

Fig. 7.—How the Spinner's Whistle is used.

vibrate in the bent-over part (Fig. 7). After a few efforts, sounds of astonishing power can be produced on this instrument.

Every boy knows how to make a willow whistle; or he may use lilac or any of several other woods when in the sap. Taking a branch about the size of his little finger, he cuts a ring in the bark down to the wood. Then, having moistened the bark in his

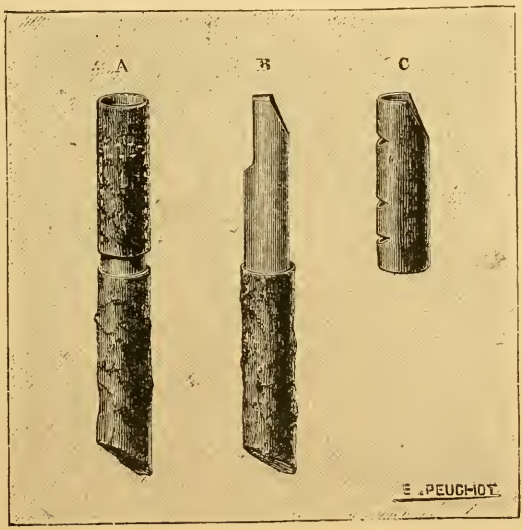

Fig. 8.—Wooden Whistle.

mouth, he beats it, holding it on his knee, with the handle of his knife, till it will slide on the stick. Holding the lower part of the branch in his left hand, with his right hand he twists the loosened slip of bark and pulls it off in a single piece, forming a

hollow cylinder, perhaps an inch long. He then slips the ring back over the stick as in A (Fig. 8), or he may trim the stick and cylinder as in B or C, previous to readjusting them, to form the shape almost universally in use.

Among the latest devices in the way of whistles are the curious chemical toys made with picrate of potash. When the whistling rockets and fire-pieces first appeared, the whistling was commonly supposed to be produced in the same way as in ordinary whistles, by the air-movements produced by their rapid motion. This is, however, not so. The operation is not at all like that of an air-whistle, but the production of the sound is owing to the peculiar property of picrate of potash of whistling when it is burned. This effect is heard very clearly with that salt when compressed in a tube, and the sonority may be augmented by the addition of various substances. Such a composition may be formed, with no other danger than usually attends the manipulation of explosives, by triturating a mixture of fifteen parts of picrate of potash and one part of Judæan bitumen. It is then charged into a pasteboard tube a little less than a half-inch in its interior diameter, and some two and a half inches long (Fig. 9). The tube is closed at one end by a plug of closely tamped clay. The composition is introduced in small charges evenly compressed, till the tube is filled to within about three quarters of an inch of the open end. The whistle may be wired upon the cartridge of a rocket, when it should be furnished with a cap penetrated by a quick match, which, entering the picrated composition, is also inserted into the throat of the rocket, so that the two fire-works shall be inflamed at the same time. The sound of these whistles is sharp at first, and passes gradually, as the tube is emptied of its contents, to a grave tone. By combining the whistles with various devices of fire-works, curious effects are produced, in accordance with which expressive descriptive names have been given to the artifices.

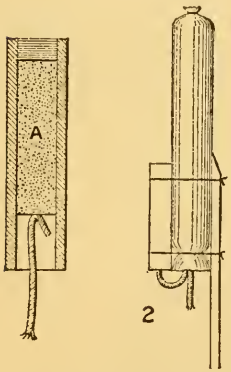

FIG. 9.—PICRATE OF POTASH WHISTLE. *a*, the whistling composition; *b*, rocket with whistle attached.

When the picrate whistles were first exhibited at Havre, on the occasion of the *Fête nationale*, the spectators, irritated at the strident noise they made, and mistaking its origin, exclaimed: "Down with the whistling fellows! duck them!" The enjoyment of the festival was much enhanced when the joke was explained.—*Translated for the Popular Science Monthly from La Nature.*

THE EARNED DECREASE *VS.* THE UNEARNED INCREMENT.

By JOEL BENTON.

READERS of Henry George's empiric philosophy have been told—and his acolytes peddle out the platitude with much phrasing and infinite iteration—that society is greatly wronged by something which he calls an "unearned increment." This unearned increment is a thing which all property, personal as well as real (if you except cash in hand and some of its exchange equivalents), is subject to. It may heap itself just as vigorously upon a dozen eggs or a bucket of soap as it does upon a piece of land. The increment arises, too, from some want or movement of society. But this habit which property has doesn't trouble these millennium-makers and poverty-extinguishers. It is only a subject for complaint, in their view, when it touches a piece of land.

The stock sample of the injustice they inveigh against is the rise in value of a town lot. In fact, you can not get the mind of a Georgeite off from a town lot. He pitches his tent there; and if, for any reason, he strays briefly away, when you are not talking to him, to the open country, a word of opposition to his whim will send him back flying to that magic foothold. One would suppose, if the fury with which he thrashes the air were really evidence, that nobody ever bought a town lot or a plot near a city who did not at once ride into a fortune by its buoyancy, or else reap a happy sum which, in equity, belongs not to him, but to everybody collectively. But the whole doctrine of Georgeism is a strange perversion of, not only political economy, but of the exact truth of the matter in hand. The history of land-ownership of all kinds everywhere is as strikingly a history of losses as it is of profits. We see the successes, as we see the ships which float on the ocean, while the unnumbered wrecks in both cases are out of thought and beyond vision.

At one time in the history of St. Paul, Minn.—to make one instance stand for a multitude—only two or three men could comfortably hold their real-estate purchases. All the rest who had investments were not only glad to give away the hope of increment, but were willing to give up all, and often more than they gave to purchase their holdings, to be freed from the debt on them. In fact, a universal bankruptcy and panic prevailed among all who owned land. It is not an uncommon circumstance to find, too, that those who buy city realty, and hold it any length of time, although the increment may seem very large, have paid

for this increment entirely through taxes, interest, and improvements. I am not sure that the man who said he had seen the time when he could buy all the ground Chicago stands on for a pair of boots, and only hesitated to do so because he lacked the boots, would have made such a wonderful bargain as might be supposed, provided he had had to pay for everything necessary in order to hold it, and had held it up to date.

But suppose, in Chicago's case, there would have been a profitable purchase for him who thought he saw the opportunity. His capital embarked, his possible risk, his care and time, would entitle him to the outcome. But what shall be said of a town not a hundred miles away from Chicago, which was laid out on the same lake with equal expectations, whose broad, houseless avenues now are—as for thirty years they have been—a silent comment on something quite different from the so-called "unearned increment"? And what of other similar would-be cities—frogs that, like Æsop's, burst themselves irretrievably, or those who took stock in them, in trying to attain the ox's magnitude? The situation in reference to disaster with the city lot is full as appalling—if foresight and gain are appalling—as it is in the direction of profit. If society has a claim upon this profit in the socialistic way which George and his followers claim it has, then, to make the equities right and even, it ought to shoulder, without a whimper, the losses which have befallen the land-owners who have suffered from the "earned decrease."

Probably, if we go outside of a few large towns (the area of all towns being an insignificant part of the planet), it will be found that what I call the "earned decrease" is a more surprising factor in the history of land than any other fact connected with it. Just now there is no farming in this country to speak of east of a line drawn as the Alleghany Mountains run, and very little east of the Mississippi River, that is really comparable in its profits with the profits of almost any other business that is good from skillful management. The farmer himself is a toiler who has—with a day's labor at least from twelve to thirteen hours long—constant obstacles against his rise, and the majority of farmers in the older States are little better off to-day than when they began their business twenty, thirty, or more years ago, provided they began without capital already earned. Who does not know, too, that the owner of land works harder than any man he employs?—frequently with less success, and always with an amount of harassing anxiety that the hired man rarely experiences, and can not, in fact, possibly experience in kind.

One only needs to make a study of the farms, as they stand all through the country, to discover that it will need a more powerful catholicon than *access to land* to cure all our social ills. Nor

is there any way to apply this remedy if it were an effectual one.

Again—to refer to the farmer once more—the land of a farm well tilled is not only now thoroughly mixed with the farmer's toil and skill in the improvement of its constituents, but it is covered with buildings, fences, ditches for drainage, and wells, that represent his hard-earned labor or his free capital applied to it. Can he get its whole value back when his estate is settled, or if he wishes to retire or remove? Very rarely—almost never, in fact. Other business plants that have been well handled usually sell out at a profit, more or less. But the farm goes off at the sacrifice of an "earned decrease." Two farms within a half-day's ride of the place where I am writing, in one of the best soiled and best settled counties in the State of New York, have lately been sold (not under legal constraint) for *less than half* what they and their improvements originally cost, involving losses respectively of from eight to ten thousand dollars. And this is not a strange or infrequent thing. It, or something like it, is one of the commonest of modern occurrences. But do we hear any school of philosophers agitated about these losses? Society, in some way, has unbuilt or leveled their value by just as responsible doings as it has by worthy and rewardable doings built up the city lot.

If it is to have the fat meat in its pudding, on what principle can it free itself from responsibility for the lean? Can society or the state play at seesaw with the owners of land? Can it say, "Heads I win and tails you lose," and ever undertake hereafter to talk about right and virtue and honesty? If it should ever hanker after the "unearned increment," there should go with it when it is passed over an accounting for the "earned decrease."

That this is not a small matter, a reference to the New England "hill-farms," so called, will amply show. In hundreds of towns there, from which the population has withdrawn itself to aggrandize certain factory towns, or to develop the West, the whole farming area has met with an irremediable loss. Farms can be bought for far less there than their surface improvements alone cost. A friend of mine bought a productive farm of one hundred and sixty acres in Massachusetts a few years ago, with a good house, barn, and other fixtures upon it—and he did not pay *the price that the barn alone cost!* Purchases of farms at a similar advantage can be made to any extent in New England, not far from pleasant country villages and near railroads, and there is no place in Massachusetts that is over twelve miles from a railroad. This means getting the land itself for *less than nothing,* which is on better terms than Henry George's creed calls for. In addition to his land, my friend had the house and fences, and some other things, thrown in. And yet the millennium

is a good deal further away from those farms than good society and the railroads are. But, according to the doctrine of those who are afflicted with George's peculiar land-fetichism, it should be already there.

It is probably true that Western farming is a better business than that which prevails in the East; but an anecdote is told of that which, if not literally true, is illustratively so for many who are engaged in farming. It does not, at any rate, overstate the gravity of the task which many persons assume who undertake to own the soil that George would sequester to the state. And this is the anecdote: A farmer in the West, who kept his business going until he nearly became bankrupt, was obliged finally to sell his farm to his chief creditor, who happened to be his faithful hired man. After a term of years the new owner found himself hopelessly in debt, and he proposed selling out to *his* hired man, who happened to be the previous owner, and who by this time was able to buy back his old farm! Whether this process of exchange continued to go on like that syllogism of Epimenides the Cretan, with no conclusion, I can not say. But when anything like it can happen once, how is a mere divisional share in the soil to mend or make over the world?

To return for a moment to the "unearned increment," the question one would like to ask is, why an increment on the value of land is any more wicked than it is upon a ton of coal or iron taken from the land? The title to a house or chair made of wood can not be good if the soil which produced the wood is held by spoliation. That which vitiates or annuls in one instance must in the others. The increment-reasoning, too, if it proves anything, proves too much. Is nothing earned in this world but mere wages? Is nothing due to foresight or perceiving what is likely to happen? Must profit all be resolved into day-wages from muscular effort solely? Are mind and thought and skill not to be considered factors which a man may use in the struggle for existence? Is the inventor, who is usually a poor toiler, to have no benefit from his wits? The sect of "labor" seems to say "No" to all these questions; and both it and the Georgeites, if they could have their way, would put us all on an express train toward barbarism and the Bedouin Arab, who is a George communist, and to the extinction of all that makes a civilized life possible.

The "unearned increment," it should be noted, is not a discovery of Henry George's. Mill and Spencer gave it a theoretical existence, but proposed no such drastic remedy for the ills supposed to flow from it as Henry George formulates and would apply. They saw that in London, where poverty is wide in extent and squalid in character beyond that of any other spot on

earth, the land on which people lived and moved rose to a fabulous value, the profit of which seemed to go to a few exclusively. The man who owns a lot in London sees it double and quadruple in value, and then double and quadruple in value again many times, not by any improvements he puts upon it, nor by any labor which he himself does, but simply by the increase of population about him, and the demands growing out of the multiplied business and wants which a population unparalleled in numbers creates. According to Mill and Spencer,* it is society, then, which makes this value of the land, and not the owner of the land. The increase which befalls it is not earned by him, but is the result of the growth of society. Why not, then, give back to society what society makes? In looking at England away from London, and at Scotland, the land problem is, in addition to this increment, made complicate by absurd laws of entail and transfer beyond anything which any other civilized country knows. Out of all this aggravation, a part of which can be reached by the modification of or the repeal of unjust laws, the "unearned increment" was suggested.

But neither Mill nor Spencer proposed to restore equality where they indicate inequalities by a wholesale system of spoliation on the innocent owners. They have not spoken of the wickedness of owning land by comparing it with the ownership of slaves, and in the same breath alleging that a full rental tax, a confiscation tax, indeed, will leave every man's ownership unimpaired. These are the absurdities which have been let loose in America only, where land can still be had for the asking, and where the appalling problem is for the man who owns land to compete—other things being equal—with the man who is not so unfortunate. It was said jocosely once, by a newspaper humorist, that a man living on a small, rocky farm in Maine, on an unfrequented road, felt visibly ashamed one day when a well-dressed traveler (as he stood in the front yard) passed his door and looked somewhat inquisitively at the dilapidated house and out-of-joint fences. As the traveler drew nearer, the supposed proprietor hastened to remark: "I am not so durned poor as ye think I be, neighbor; I don't own this 'ere land!" The joke is now too universal to be any longer humorous to the average land-owner.

Suppose we were to admit that some injustice exists in the irregular distribution of the rapid increase of land-values in large towns. The inequality is one which no legislation could

* After calling this spirit from the "vasty deep," both Mill and Spencer failed to lay it, or to suggest any means whereby it could be placated. Allodial ownership, whether rightful or wrongful in the beginning, was to them at this present moment a right and a fact too overwhelming to be whisked away by a mere breath of metaphysical analysis.

possibly remove without opening a door to immeasurable evil and wrong. Wealth itself is an inequality which renders possible the most lurid contrast in conditions of human happiness. To see the brown-stone front with a gilded carriage at the door, while a hovel with starving inmates is not many blocks away, suggests a train of thought as pathetic as anything the world has to show. But you can not abolish wealth without punishing economy and thrift, and taking away the incentive to rise in the world. You can only abolish it by abolishing civilization, to which wealth and poverty are incidents ; and poverty you can not abolish, either while civilization lasts or after it is destroyed. Nothing was ever truer—as a declaration for the present, a description for the past, and a prophecy for the future—than the statement, "The poor you have always with you."

But schemes have been suggested for limiting wealth in one way and another, either by extinguishing the owner's power to bequeath it at all, or by reducing to a small allowance what may go to his children, or what he may bequeath ; or by taxing each additional ten thousand dollars acquired above the first ten thousand at such a frightfully increasing ratio as to make the incentive to obtain money no longer attractive. This is a backhand way of trying to abolish poverty, or make it more tolerable by making everybody poor compulsorily. You can not do a more effective thing toward paralyzing energy and industry, and offering a bounty to laziness and unthrift, than to make the thrifty men of the world draw all the sloth and incompetence along. This is taxing them not only to support poverty, but to multiply it and make it prevail.

I have been comparing here the evils that seem to have relation to wealth with those which seem to some to grow out of the "unearned increment." But if it is a fact that a hovel of starving inmates can be seen not far from the palace of a man of wealth, is it not even a more closely related fact that the rise of the palace, and the man who lives in it, has directly helped thousands of honest toilers, and continues to help such, whether the man who is wealthy wishes to help them or not ? But we do not notice, on account of this hovel, the thousands of well-to-do workers all over the land who have drawn tribute for years from this wealthy man's multiplied wants and luxuries, and who live plainly and comfortably from the fact that he and others like him live luxuriously. A society where wealth exists has evils, because evil is inevitable ; but to cripple or destroy wealth would bring a deluge of disasters which no man, if he could foresee them fully, would be able to avert. I have been supposing what I do not believe, that the "unearned increment" involves some element of wrong. In continuing the supposition, I

must now emphatically remark that it really can not happen as a merely private benefit at all any more than wealth can happen as such. In a town of immensely rapid growth where this increment arises, the honest laborer and poor man who does not care to acquire land, or does not foresee the opportunity open to him, or can not command the means for doing it, still receives unparalleled opportunities in any pursuit he follows there. Wherever a so-called "unearned increment" arises, there society at large has reaped connected benefits which have been widely distributed. It would not be easy to set down how far this wave of advantage spreads; but we all know that it spreads very far, and that he is a very dull or a very shiftless man, who lives where it starts, who does not find some part of it beat over into his own cup, be it large or small. And the trouble which would arise from despoiling those who in a few instances have, by acquiring land, apparently obtained too easy a profit, would be the killing of the goose which had laid for the whole public the golden egg. It is more than probable that the "unearned increment" which has come to the land-owners in that Kansas town which has, in five years, jumped from a population of five thousand to nearly forty thousand, has gone in the largest measure to men who planned and made the progress seen there possible. In places where this is the case in a less degree, the effort to make things equal is a problem too great for any but angels and seraphs to deal with. No merely human device can touch it without breaking or deranging the mainspring of civilization. Yet there are plenty of fools who dare step in where angels fear to tread. The man who burned up his barn filled with grain to destroy a hornets' nest is not alone in the world. He now has a *cult* and a body of disciples.

Seeing, as all may, how little land does for its owner everywhere, and for an owner who has the utmost possible incentive that the strong motive of human selfishness supplies to enable him to succeed (which the state could not have), what possible hope can there be of any betterment of things by transferring all land to the state or to society collectively? Through what magic or enginery is it that the state is to conduct all its farms to a profit, and so rent city lots as to produce more benefits than now exist? No one not stricken with asinine idiocy can begin to tell.*

* It ought not to require any argument to see that every man who holds land to improve it, or who buys worthless land to make it valuable, is the friend and not the enemy of mankind. Private ownership of land, as it now exists, is largely a sacrifice for the public good. For it must be remembered that it is not direct *access to land* that is in the least degree necessary to any one individual, or to any one million of individuals. What *must* be had is simply access to the products of food, raiment, and shelter which land supplies. Now, if somebody else will do unprofitable soil-culture for my benefit, I will

How, too, is this needful transfer of land to the people to be made? This step is the *pons asinorum* which Mill and Spencer revolted from, and which George does not successfully cross. For the people to buy themselves out, would be the only honest way of transfer; but this would be like a man standing in a corn-basket and trying to lift himself by its handles over the fence. McGlynn, George's prophet and Hotspur, cuts the bridge down, and says all land must be taken, without compensation to the present "miscalled owners," and given directly to the state. It is not strange, with this crude conception of morals uppermost, that the new "crusaders" should not have a word to say of the "earned decrease." This whole scheme is all as shallow a piece of folly as the history of delusions will have to record. It will very properly take its place with "the moon-hoax," and with Captain Symmes's tubular theory of the earth, when the nine days' wonder of it, now waning, shall have collapsed.

THE EFFECTS OF MODERATE DRINKING.

By GEORGE HARLEY, M. D., F. R. S.

IT is because of there being at present such diverse views expressed regarding the influence moderate drinking has on the constitution, that I am tempted to contribute my mite of knowledge to the general stock, in the hope that what I relate may suggest new ideas in the minds of others who, like myself, are interested in the study of this intricate question. For I regret to find that, notwithstanding there has already been so much written, and well written, on the action of alcohol when taken in excess, no one appears as yet to have thought it worth his while fully to tackle the subject of moderate drinking. The reason of this, perhaps, is not far to seek, seeing that a little reflection reveals the fact that, although the majority of persons may truthfully be said to be moderate drinkers, and consequently medical men see far more patients belonging to this category than any other, they possess but very little opportunity of studying the effects of alcohol, when thus indulged in, upon the constitution, for the following reasons: 1. There

not stigmatize him as a robber; I will, on the contrary, exalt him as a public benefactor. Somebody has been lately computing the millions and hundreds of millions of mortgages which the farmers in our most thrifty agricultural States are now carrying. I will not name the sum total, except to say that its size is perfectly appalling. When I think of this, and the other facts dismally related to it, I feel like taking off my hat to every owner of the soil, and saying: "My good fellow, you have my supreme respect; for if you should ever be driven off, or abdicate, chaos and destruction would indeed come."

are not only no tables of statistics as to its effects in existence, but there are no means of acquiring them; the statistics of the effects of drunkenness, of which there are abundance of greater or lesser value, being unfortunately of no service whatever in solving the problem of the effects of moderate drinking either on mind or body. 2. In no instance are the effects sufficiently marked to necessitate any special form of treatment in a public institution. 3. The deleterious influences on the bodily functions are so insidious as in the early stages either totally to escape detection, or, what is more common, to lead them to be attributed to some entirely different cause. 4. The effects of moderate drinking manifest themselves in such a variety of different forms, that, even when their true nature is recognized, the general practitioner has not the opportunity of seeing a sufficient number of any one of them to admit of his drawing conclusions from them. 5. The men who have most experience of the severer forms of functional disease directly traceable to the effects of moderate drinking are, in general, merely those who, like myself, make liver and kidney diseases a special study; the liver, kidneys, heart, and brain being those organs of the body most affected by alcohol when indulged in within the limits of what is called moderation. Notwithstanding this fact, it being impossible for me, or even any one else specially engaged in the treatment of liver and kidney diseases, to collect a sufficiently large number of telling cases from which to deduce crucial data of the deleterious effects of small quantities of alcoholic stimulants habitually indulged in by temperate men, I purpose adopting the plan of drawing conclusions from the statistical data of the effects of alcohol on the human constitution when it is taken in the form of what is called "nipping"—that is to say, small quantities only being taken at a time, but frequently in the course of the day. Of these, fortunately, the registrar-general's reports of our national mortality in different industries furnish us with something approaching to reliable data. So I shall make use of them, along with some German statistics of a similar character, in illustrating the probable pathological effects of moderate drinking on the human constitution. For when one can not get what he wants, it is good policy to make use of what he has got, on the principle that half a loaf is better than none. 6. Added to all these drawbacks to the formulation of reliable conclusions regarding both the direct and indirect effects of alcoholic stimulants, taken in small quantities at a time, upon the vital functions, there is yet the other of reconciling different minds with what is exactly meant by the term "moderate drinking," seeing that a quantity which one would call moderate is not at all unlikely to be by another designated immoderate

drinking. Before attempting to define the intrinsic value of the two words, let me remind the reader that the mere use of the term "moderate," when applied to anything whatever—whether it be to walking exercise, or anything else—implies that it is merely a relative and consequently a fluctuating quantity, according to the capabilities of the individual and the circumstances of the case; for a moderate walk to a weak person is quite a different thing from a moderate walk to an athlete. So the term "moderate drinking," when applied to a girl in her teens, is something quite different from the term "moderate drinking" when applied to a robust man. Consequently its intrinsic value is not to be measured by quantity, but by the effects; and fortunately, as every thinking being is capable of doing this for himself, it is quite unnecessary for me to fix upon any given quantity, but merely to say that by moderate drinking I mean the indulging in alcoholic stimulants well within the margin of intoxication. I shall, for the present, confine my remarks on the effects of moderate drinking to those more particularly observed on the four important and indispensable organs of the body—namely, the liver, kidneys, heart, and brain.

Although all persons who indulge in alcoholic stimulants well within the margin of actual drunkenness speak of themselves as "moderate drinkers," there are two special classes of them which bear no resemblance to each other, except in the one solitary circumstance that they never at any time take sufficient to intoxicate themselves. The one class is that which only partakes of stimulants while eating; the other indulges in them between meal-times. To the latter habit is applied in this country the title of "nipping," while in the East it is spoken of as "pegging." And this is the most pernicious of all forms of drinking, from the fact that stimulants taken without at the same time partaking of food, though only imbibed in small quantities at a time, have most deleterious effects on the internal organs. A man who habitually indulges in a single glass of sherry in the forenoon, a brandy-and-soda in the afternoon, and a glass of whisky-and-water in the course of the evening—for reasons presently to be explained—does far more injury to his constitution than one who partakes of a larger quantity of alcoholic stimulants at meal-times. That this is not a mere ideal opinion evolved from the realms of fancy, but one founded upon an indisputable basis, I shall show by reference to the tables of mortality furnished by the registrar-general in his annual reports. As there, unfortunately, exist no especial tables of mortality from this form of moderate drinking, I have adopted the plan of estimating its effects on health by comparing the death-

rates given in the reports of persons who, in the course of their vocations, are exposed to the temptation of taking small quantities of alcoholic stimulants between meal-times, with the recorded death-rates of those, at the same ages, whose trades and modes of life do not so expose them. And the results are, I think, perfectly conclusive. For they not only furnish us with a comparative absolute average death-rate in the two sets of cases, but, in no ambiguous language, point out the exact organs of the body that are most affected by nipping, and give us the relative proportions of the deleterious influence it has upon each of them.

First, then, as regards the influence of "nipping" on the liver and kidneys—the two organs of the body not only more immediately affected, but most closely corelated, from the fact that when the one is diseased the other has to perform its functions, as best it can, vicariously. Seeing that the average proportion of drunkards is about the same in all industries, when it is considered on such a vast scale as over the whole nation's strength, I scarcely think any one will doubt the trustworthiness of the results as revealed in the subjoined tables: *

Death-Rate of Men between the Ages of 25 and 65.

Men exposed to the temptations of "nipping."	Liver diseases.	Urinary diseases
Commercial travelers	61	44
Brewers	96	55
Innkeepers, publicans, vintners, barmen, and waiters	240	83

The comparative death-rates of men of the same age engaged in other industries, not exposed to the temptation of "nipping," are, again, as follows:

Death-rate of men not exposed to the temptations of "nipping."	Liver diseases.	Urinary diseases
Gardeners and nurserymen	18	39
Printers	28	30
Farmers and graziers	41	31
Drapers and warehousemen	35	37

As an addendum to these most telling statistics, I think I can not do better than quote what Baer says regarding the probabilities of life in persons exposed to the temptations of "nipping" compared with that of those not liable to be so tempted. The following is extracted from his table of Prussian statistics,† and I arrange them for the sake of easy comparison in two parallel columns, showing the probable duration of life calculated at different ages:

* "Supplement to the Forty-fifth Annual Report," 1885, p. 32.

† "Deutsche med. Wochenschrift," January 20, 1887.

AGE.	PROBABLE DURATION OF THE LIFE OF MEN.	
	In the liquor trade.	Not in the liquor trade
25	26·23	32·08
35	20·01	25·92
45	15·19	19·92
55	11·16	14·45
65	8·04	9·72

This, as is seen, is an equally instructive table.

To return for a moment to the part played by the so-called moderate use of alcoholic stimulants in the production of fatal forms of liver-disease. As it is, I think, impossible that we as medical men can know too much regarding the probable deleterious effects of mere "nipping," I here subjoin an extract from the registrar-general's tables of the comparative mortality from liver-diseases in different industries, between the ages of twenty-five and sixty-five, in the years 1880–'82, which exhibits the matter in a stronger light than any words of mine can possibly do:

Bookbinders	3	Butchers	21
Booksellers	4	Fishermen	22
Hatters	9	Brewers	42
Tobacconists	10	Innkeepers, publicans, vintners, waiters, and barmen	197
Druggists and printers	18		
Gardeners and miners	19		

The result here shown is so startling that the registrar-general not inappropriately designates it as "appalling," seeing that the proportion of deaths from liver diseases is in reality six times greater among men exposed to the temptations of "nipping" than in that of all the other industries combined—the actual figures being: For brewers, 1,361; for vintners and other salesmen of wines, spirits, and beers, 1,521; and for waiters and barmen (those most exposed to temptation), no less than 2,205: whereas, for maltsters, who are only concerned with the materials from which intoxicants are manufactured, and not with the intoxicating liquids themselves, the death-rate is only 830. Nothing could be more conclusive of the deleterious effects of so-called moderate drinking on the human constitution than this; for, as all different effects in this world originating in identical causes are but relative, it is readily seen how a lesser proportion of "nipping," though giving rise to lesser results, must nevertheless cause a proportionate amount of cases of disease in the liver and kidneys to those given in the above tables.

Notwithstanding the familiarity of medical men with the fact that many cases of hepatitis, chronically enlarged liver, and cirrhosis are directly traceable to inebriety, few, I fancy, can have

been prepared, without some special acquaintance with the subject, for the information furnished by the foregoing mortality tables of the potent action of alcohol on the liver, when only taken in small quantities at a time. And, although it may at first sight appear strange that the liver of all the organs of the body should be most potently affected by moderate drinking, I think one can scarcely be surprised at this if he is acquainted with the peculiar action of alcohol introduced into the liver by the portal vein. For it requires, I think, but a small amount of reflection on the part of those acquainted with the mechanism of digestion to understand how alcohol, when taken into the stomach, even in small quantities at a time, is a powerful agent in the production of hepatic disease. Seeing that most of the liquid products of our food are carried directly from the intestines to the liver by the portal vein, it consequently follows that almost every drop of the alcohol, be it small or be it great, taken into the stomach must be directly conveyed by the portal vein to the liver, and compelled to filter through its tissues before it can possibly get into the general circulation and reach any of the other organs of the body. The knowledge of the fact that all the imbibed alcohol is directly conveyed to the liver by the portal circulation not only gives a clew to why alcoholic stimulants are so prone to induce hepatitis, as well as to increase the formation of sugar and aggravate diabetes, but to bring about an attack of gout; seeing that the liver is regarded as the main source of both sugar and uric acid—the supposed gout-forming material. In addition to which, the direct conveyance of alcohol to the liver affords us a reasonable explanation of why alcohol taken along with the food is so much less detrimental to the constitution than when it is taken on an empty stomach. Moreover, it is now a well-known fact that the continuous excitement of the liver, kept up by habitual "nipping," is far more injurious to its functions than an occasional outburst of drunkenness followed by intervals of strict sobriety. It equally accounts for the fact that the liver is not alone the first organ of the body that becomes affected, but is at the same time the one most seriously disordered by moderate drinking.

The effects on the kidneys of moderate drinking are far less apparent than upon the liver; nevertheless, they are sufficiently marked to merit attention. The reason why the kidneys suffer so much less from the imbibed alcohol when it is taken in only small quantities at a time is sufficiently obvious, seeing that a large quantity of what passes through the liver never reaches the kidneys at all, from a considerable part of it having been eliminated by the breath during its passage in the blood through the lungs. That intemperance is a fruitful source of Bright's

disease has long been known, and the reason of this is not far to seek, seeing that it is the special duty of the kidneys to eliminate alcohol from the general circulation—as they do all other foreign materials. And the more work that is thrown upon an organ, the more prone are its tissues to become degenerated. Not only, however, do we know that the kidneys eliminate the imbibed alcohol (from its being met with in urine), but we likewise know that alcohol, as alcohol, saturates the renal tissue to such an extent that I and others have been able to obtain pure alcohol from the kidneys of persons who have died intoxicated by the simple process of distillation. Besides all this, however, there is a special reason why the kidneys should become diseased in so-called moderate drinking; and that is on account of the circulation being incessantly increased in them, as it is elsewhere, from the accelerated heart's action induced by the repeated imbibition of stimulants in small quantities. For no doubt the diameter of the renal blood-vessels is augmented by their engorgement, and consequently they exert a deleterious pressure on the intervascular tissues, which will interfere with their proper nourishment. While, further, this engorgement of the renal vessels will render the kidneys more liable to the injurious effects of chills; and chills are, as is well known, the most fruitful cause of kidney disease. This view of the case appears to me to give not only the clew to the reason why Bright's disease is so particularly common among the inebriate, but likewise why transient attacks of albuminuria are so frequently met with in moderate drinkers, among both men and women. Spirit-drinking is said to be mainly instrumental in inducing the variety of renal disease named granular kidney; while beer-drinking is, on the other hand, thought to be most potent in bringing about fatty degeneration of the renal tissues. Be that as it may, I well know, from a long experience of urinary affections, that even small quantities of alcohol habitually indulged in sometimes bring on most troublesome forms of albuminuria, without there being any well-marked symptoms of the existence of either granular or fatty degeneration of the tissues of the kidneys.

Alcohol, when taken in small quantity, is in general said to act as a direct cardiac stimulant, and its stimulating effect is supposed to be due to its possessing the faculty of increasing the muscular power of the heart. I take an entirely different view of the matter, and shall now endeavor to show how the increase in the force of the heart's movements, the quickening of the pulse, the flushing of the face, the congestion of the retinal blood-vessels, as well as all the other visible appearances of accelerated cardiac functional activity, are in reality in no wise due to the stimulating action of alcohol, either on the heart's

muscular tissue or the nerves supplying it, but actually to the very reverse—namely, its paralyzing effects on the cardiac nerve mechanism. This may appear a strange idea to those unfamiliar with the advanced theories regarding the accelerating and restraining heart's nerve-forces. Nevertheless, it is quite consonant with the results of modern physiological investigations, which go far to prove that every function of organic life—no matter whether it be the expulsion of the urine, the peristaltic movements of the intestines, the throbbings of the heart, or involuntary respiration—acts under the immediate influence of a bifold nerve mechanism. For example, the human heart is endowed with two entirely different and opposing centers of nerve-force, and so retroactive are their respective functions that the sole duty of the one appears to be to regulate and control the functions of the other. To the former has been given the name of inhibitory or restraining mechanism; to the latter that of the exciting or accelerating nerve agency. Destroy or paralyze the inhibitory nerve-center, or arrest its power of communicating with the heart by dividing the vagus, and instantly its controlling effect on the cardio-motor mechanism is lost, and the accelerating agent, being no longer under its normal restraint, runs riot. The heart's action is increased, the pulse is quickened, an excess of blood is forced into the vessels, and from their becoming engorged and dilated the face gets flushed and the retina congested—all the usual concomitants of a general engorgement of the circulation being the result. Instead of paralyzing the vagus by section, and thereby arresting its inhibitory cardiac nerve-power, paralyze it through the instrumentality of a toxic agent, and precisely the same chain of phenomena will of necessity be the result. The most powerful paralyzer of the vagus we at present know of is atropia; and what happens when it is given in a full dose? Nothing more or less than the effects we have here attributed to the section of the vagus—tumultuous heart's action, quickened pulse, congested face and eyes, etc. Alcohol acts on the heart, I believe, in precisely the same manner as atropia does, although less strongly; that is to say, it quickens the heart's action, as well as apparently increases its power, by paralyzing its restraining or inhibitory nerve mechanism. This, however, is only the primary action of alcohol on the cardiac organ, for no sooner is the quantity administered sufficiently increased than all its at first apparently stimulating effects vanish. From its now possessing adequate power to paralyze the accelerating as well as the retarding cardiac nerve mechanism, the heart's action, therefore, now becomes diminished *pari passu* with the amount of the paralyzing agent employed, until at length (if a sufficiency be given) the cardiac

movements are totally arrested, and death closes the scene. Effects on the human organism being, when properly interpreted, like effects in the inorganic world—exactly proportionate to cause—the at first sight apparently stimulating and consequently salutary action of alcohol on the heart, when taken in moderation, is as much due to the alcohol's paralyzing power as the destruction of all vital action is its result when it is taken in poisonous quantities. From this, however, it is not to be inferred that its incipient paralyzing power over the inhibitory cardiac nerve mechanism must necessarily be in all cases detrimental. On the contrary, it may actually in many instances be beneficial. Just in the same way as atropia, strophantus, digitalis, and daturine—which are all cardiac inhibitory nerve paralyzers—prove exceedingly useful medicinal agents when they are judiciously employed in appropriate cases. So alcohol, by the doctor's skill, may in like manner be so used as to paralyze to cure, and not to kill.

It being well known that intemperance is a most fruitful cause, not only of all the various forms of heart-disease, but likewise of the degenerations of the coats of the blood-vessels, all I at present require to do is to prove that even what is called moderate drinking has a much greater share than is generally supposed, in not only greatly increasing heart-diseases, in cases where they already exist, but also in inducing their development in the constitutionally and hereditarily predisposed to become affected by them. The reason why moderate drinking should induce not only hypertrophy and dilatation, but likewise valvular disease of the heart, is not far to seek—from its being a recognized fact that every increase in a muscle's activity is associated with an increase in its development, as well as its tension on the parts with which it is connected. The truth of the foregoing statements will, by a little reflection, be gleaned from the results of drinking small quantities of alcohol frequently during the day, as manifested by the figures in the subjoined table of mortality I have drawn up from the registrar-general's reports,* of the relative frequency of diseases of the circulatory system among men between the ages of twenty-five and sixty-five employed in different industries. For it not only shows the effects of so-called moderate drinking *per se*, but likewise the still more pernicious effects of it when it is associated with intermittent muscular strain—that is to say, when the stimulus of alcohol upon the heart has superadded to it an increase in the heart's activity necessitated by oft-repeated sudden muscular

* Supplement to the forty-fifth Annual Report, 1885, which takes in the whole previous ten years' death-rates, and may consequently be accepted as yielding a reliable average.

efforts; for while it shows that all exposed to the partaking of alcoholic stimulants in small quantities at a time are much more frequently affected with the fatal forms of cardiac diseases than others, it in an equally unmistakable way shows that men who, like brewers, require in the course of their trades to tax their muscular strength, and thereby throw additional work upon their hearts, are far more often attacked with the fatal forms of diseases affecting the circulatory system than men equally addicted to imbibe alcoholic stimulants, but who are not called upon to make similar kinds of straining muscular efforts.

The relative proportions of deaths from diseases of the circulatory system in the different classes are:

Those not exposed to the temptation of drinking.		Those exposed by their vocations to the temptation of drinking.	
Drapers and warehousemen	75	Commercial travelers	100
Gardeners and nurserymen	82	Vintners, waiters, and barmen	146
Printers	93	Brewers	165

Moreover, it is equally known that intemperance is a most active agent in the induction of atheromatous (fatty granular) degenerations in the coats of the arterial system, and as such a fruitful source not only of death by cardiac syncope, but likewise by apoplexy, from the cerebral vessels being quite as frequently and as severely affected with the degeneration as those of the heart itself, and the coats of the one set being as liable to sudden rupture as those of the other, if not, indeed, even more so, from the less solid nature of the brain surroundings. I wish now to call special attention to what I believe to be a fact—namely, that what is termed "moderate drinking" is a far more general cause of atheromatous degeneration of the coats of the blood-vessels than is usually supposed.

It is, I believe, next to impossible to overrate the desirability of impressing patients laboring under heart-disease, as well as atheromatous degenerations of the blood-vessels, with the absolute necessity of being extremely temperate in the use of alcoholic stimulants, if they wish either to live long or to ameliorate the disease of the circulatory system under which they labor. For alcohol taken in the form of spirits—brandy, whisky, gin, or rum—even in teaspoonful doses, by increasing the heart's action has quite as pernicious an effect on the organic structural disease, be its form what it may, as belladonna itself. And I fancy all who have much experience with cardiac diseases know well the intrinsic significance of this remark.

In the early stages of organic disease of the heart or blood-vessels judicious regimen is quite as essential to the well-being of the patient as wise treatment: for, if the case be skillfully handled, it is not only possible for death to be long averted, but

even the effects of the organic changes reduced, and, like the cracked jug which goes often to the well, the life of the patient may be prolonged for years; while, on the other hand, if the true nature of the case fail to be early recognized, and the patient goes on living as if there were nothing the matter with him, the disease rapidly advances, and ere long the time arrives when it is utterly beyond human power to avert a more or less suddenly fatal ending.

After having so forcibly pointed out the baneful effects of even small quantities of stimulants in diseases affecting the heart and blood-vessels, I think it is time for me to show that in these cases the laws of therapeutics are not, like those of the Medes and Persians, unalterable. This arises from the fact that even the same forms of organic disease affecting the circulatory system occasionally differ very materially in their characters as well as in their course, not only from the special constitutional peculiarity of the patient, but likewise in a marked degree from the different circumstances under which he is placed; so that stimulants may be employed in one case as a useful adjunct to other treatment, in spite of their being absolutely forbidden in another. In all cases, however, their employment can only be sanctioned under medical advice, for, from its being always much easier to put a thing wrong than to set a thing right, therapeutical combined with pathological knowledge can alone be safely intrusted to decide whether or not alcohol can be given with either advantage or with safety in any given case of cardiac disease. Even here, however, some general rules for alcoholic treatment can be notified; for there is no doubt whatever that, in all cases of cardiac syncope, spirits, in the shape of brandy, rum, whisky, or gin, are potent heart revivers, especially when there exists no actual organic disease of the organ. And even in certain cases where there are valvular derangements alcoholic stimulants may be had recourse to with marked benefit. Moreover, from the fact of alcohol being a powerful anti-flatulent, there is scarcely a single case of organic disease of the heart in which it may not sometimes be administered in small quantities at a time with marked advantage.

Finally, I think it may be said that the various facts adduced appear to prove—1. That alcohol, when indulged in, even well within the limits of intemperance, has a most prejudicial effect on heart-disease. 2. That sudden spurts of muscular exertion act most deleteriously on all forms of organic cardiac affections. 3. That mental excitement is a cause of rupture of atheromatous blood-vessels. 4. That a mere extra-distension of a stomach by wind may suffice to fatally arrest a diseased heart's action. The knowledge of these facts has for some years past led me to make

it an invariable rule to impress upon all patients laboring under diseases of the circulatory system, who desire to minimize the effects of their complaints and ward off as long as is possible the inevitably fatal termination, to pay strict attention to what I call the following three golden rules: 1. Take exercise, without fatigue; 2, nutrition, without stimulation; and, 3, amusement, without excitement.

As the consideration of the effects of alcohol on the brain, when taken in excess, lies entirely outside of the scope and purport of this essay, I at once proceed to call attention to the as yet but imperfectly known subject of the influence of small quantities of alcohol on brain-diseases. And it being my desire to make the effects of moderate drinking as strikingly apparent as is possible, as there are no statistics of the effects of it forthcoming, I fall back upon the data furnished in the registrar-general's reports regarding the comparative ratio of mortality from diseases of the nervous system occurring among men between the ages of twenty-five and sixty-five in different industries. For they tell so startling a tale of the baneful effects of taking small quantities of alcoholic stimulants frequently during the day, that no one accustomed to analyze results deducible from collateral evidence can fail to appreciate their intrinsic value in the elucidation of the point in hand. The registrar-general's report * tells us that the relative mortality is as follows:

Men exposed to the temptations of "nipping."	Diseases of the nervous system.
Commercial travelers	139
Brewers	144
Innkeepers, publicans, wine, spirit, and beer dealers	200

Men not exposed to the temptations of "nipping."	Diseases of the nervous system.
Gardeners and nurserymen	63
Farmers and graziers	81
Printers	90
Drapers and warehousemen	109

The above figures speak to the reflecting mind in no ambiguous language, so that I need make no comment upon them save to call special attention to the fact of diseases of the nervous system being so much more common among drapers and warehousemen than among the equally indoor occupation of printers: the only tentative explanation which I dare venture to adduce from this fact being that, as it is worry, little fidgeting mental worries, that conduce more than mental work (not excessive) to shatter the nerves, the high percentage of diseases of the nervous system met with among drapers and warehousemen is possibly due to their being more liable to be mentally harassed in the

* Supplement to the forty-fifth Annual Report, 1885.

course of their daily vocations than printers, who are as a rule not subjected to anything like a similar class of petty annoyances during their work, no matter how arduous it may be.

That after the liver and the heart the brain should be the next organ of the body which suffers most from the injurious effects of alcohol when taken in small quantities at a time is no more than what might be expected. Indeed, I think it is even less, seeing that alcohol acts injuriously upon nerve-tissues in three distinctly different ways: First, through its chemical action upon the blood; second, by disordering the liver's functions and causing the bile to accumulate in the circulation, and thereby poison the brain and nerves; and, third, by its accelerating the heart's action, and thus sending an increased supply of blood to the brain—every increase in an organ's blood-supply being associated with a corresponding increase in the functional activity of the organ.

The increase of the cerebral circulation consequent upon the increase in the heart's action from the imbibition of small quantities of alcohol acts prejudicially, however, upon the brain in yet another way—namely, by its causing an engorgement and dilatation of the cerebral arteries. For, seeing that Nicol and Mossop found that so small a quantity as two teaspoonfuls of absolute alcohol caused marked congestion of the retinal blood-vessels—which derive their blood-supply from the same source as the cerebral vessels—it is natural to infer that even the small quantity of two teaspoonfuls of alcohol will induce the same amount of congestion in the branches of the blood-vessels within the cranium as it does in those immediately outside of it; and if so, seeing that the organ is confined within a limited space and surrounded on all sides by unexpansible ridged walls, by their engorgement and dilatation they must of necessity press injuriously upon the brain-substance. The pressure thus exerted on the nerve-cells and fibers will not only prevent their performing their functions properly, but at the same time interfere with their nourishment, and consequently lead to a degeneration of their constituents. The deleterious effects of congestion of the intercranial blood-vessels are rendered apparent to us in yet another way—namely, by the feelings of fullness or tightness of the head experienced by many persons after partaking of alcoholic stimulants. Moreover, it appears to me that the facts just alluded to afford a reasonable explanation of why it so often happens that persons who indulge in small quantities of spirits while engaged in arduous mental labor frequently suffer from a sudden mental breakdown, notwithstanding that the immediate effect of the stimulants had appeared to be beneficial to them by increasing their brain-power. My explanation of the cause of

the mental collapse is, that the brain, like every other organ of the body, while in a state of functional activity, draws to it a super-supply of blood, and consequently, when alcohol is taken, it adds to the already existing engorgement of the cerebral vessels arising directly from the brain's activity, by accelerating the heart's action, and thereby augmenting its deleterious effects by still further increasing the pressure exerted on the nerve-cells and fibers by the already dilated and engorged vessels.

We shall now for a moment glance at the injurious effects of small quantities of alcohol exerted on the brain through the intermedium of the hepatic derangements that stimulants induce.

The very large number of nerve affections, more especially in the form of intellectual disturbances, which come under the notice of liver specialists, are in a great measure attributable to the disorder of the biliary functions brought about by the habitual indulgence in small quantities of alcohol between meal-times; for, as is well known, scarcely a more formidable cerebral poison than bile exists.

Sometimes one learns from a patient a great deal which he may turn to account in the treatment of others; and one of the things a patient taught me was the marvelously depressing after-effects that a single glass of spirits will occasionally produce in a bilious subject. A leading member of our own profession, who is a martyr to biliousness, made a number of experiments upon himself regarding the depressing after-effects of alcoholic stimulants, and he tells me that he has repeatedly found that a single glass of gin, whisky, or brandy, taken diluted with water, either at dinner-time or in the evening, when he is bilious, and feels exhausted after his day's work, will be followed in from five to fifteen hours with such a morbid depression of spirits that he scarcely knows what to do with himself; yet the primary effect of the stimulant is, he says, not only refreshing but exhilarating. This, although an exceptional case in so far as its severity is concerned, is but the type of many others that have come under my notice; for some have said that a single tablespoonful of brandy, whisky, or gin, will induce depressing after-effects when their livers are out of order.

The only way in which I can account for this depressing after-effect of small quantities of alcohol, when taken by bilious persons, is by imagining that the small amount has the power to exert a more than usual deleterious influence on the cerebral tissues in consequence of their having been already materially weakened by the direct poisonous effects exerted on the nerve-tissues by the bile in the circulation. I am led to this opinion from noticing how much less the depressing after-effects of spirits become so soon as the liver's functions are put to rights.

The brain and liver disorders induced by alcohol thus appear to be as closely correlated as those of liver and kidney. The mere fact of a splitting headache following upon a debauch in the case of a strong, healthy man, and a frontal or an occipital pain succeeding the drinking of a single glass of sherry in a nervously weak one, may be regarded, I think, as proof positive of the detrimental effects of alcohol on the nerve-tissues, as well as lead us to suppose that it is most probably due to the compression of the nerve-cells and fibers, which, as I have above tried to explain, may probably arise from the alcohol accelerating the heart's action, and thereby increasing the circulation in the intercranial vessels.

This statement necessitates the making of another—namely, that atheromatous degenerations of both the cardiac and cerebral blood-vessels are particularly common among men of great muscular and mental activity, who are in general spoken of as "good livers."

I have now to call attention to what appears to be a reverse kind of preliminary alcoholic effect on the nervous system—namely, that which is observed in the incipient stage of intoxication, and is almost invariably spoken of as a pleasant instead of a disagreeable sensation. Although I imagine that when a small quantity of an alcoholic stimulant is taken, the pleasurable feelings experienced may be probably entirely due to its increasing the cerebral circulation, I nevertheless think that when the amount taken is sufficient to be ultimately able to lead to complete unconsciousness, the preliminary stage of the intoxication, which has been described by some as one of sweet *sans souci*, is simply the offspring of a blunting of nerve sensibility—in fact, merely a partial or incipient stage of cerebro-spinal paralysis; precisely in the same way as feelings of a pleasing calm are oftentimes felt to precede the total unconsciousness of refreshing sleep, and soothing sensations of agreeable beatitude have been described as their feelings by persons who after a lingering illness have quietly and peacefully slipped away into eternity. In all of these cases the pleasurable sensations experienced are merely, I believe, due to the gradually increasing negation of nerve-sensibility.

Lastly, as regards the deleterious influence that small quantities of alcoholic stimulants exert upon the brain-tissues through the power they possess of so acting on the nerve-pabulum in the blood as to prevent its taking up oxygen and exhaling carbonic acid, and thereby becoming fitted for the purposes of brain nutrition. Alcohol does this exactly in the same way, though to a somewhat lesser extent, as opium. This is well shown by the results obtained from a series of experiments I performed on the

subject some years ago, a full account of which was laid before the Royal Society, and published in its "Transactions" in 1864, under the title of "The Action of Physical and Chemical Agents upon the Blood, with Special Reference to the Respiratory Process."

The relative effects of alcohol and opium were found to be as follows:

IN 100 PARTS OF AIR.	Oxygen.	Carbonic acid.	Nitrogen.	Vol. at 0° C. and 1 metre pressure.
Composition of employed air	20·9	0·002	79·038	20·96
With pure ox-blood	10·58	3·330	86·09	14·91
With pure ox-blood + 5 per cent of alcohol	16·59	2·380	81·03	18·97
With pure calf's-blood	6·64	3·47	89·89	10·11
With pure calf's-blood + ·005 grm. of morphia	17·17	1·00	81·83	18·17

A glance at this table suffices to show that alcohol, even in the small proportion of five per cent, exerts a powerful chemical effect on blood, so powerful as to entirely derange one of its most important functions—namely, the function of respiration. The alcohol seems to have acted like an asphyxiant, inasmuch as it has not alone diminished the power of the red corpuscles to absorb oxygen, but to exhale carbonic acid, and that too in the same way, though to a somewhat lesser extent than morphia does. This peculiar chemical action of the alcohol on the blood nerve-pabulum may be thought to give a reasonable explanation of the paralyzing action of alcohol upon the nervous system, seeing that oxidation is the motor power of all vital action, and in direct proportion to its activity are the manifestations of life accelerated or retarded. Every breath we draw, every movement we perform, every thought we think, is but the outcome of the transformation of matter under the influence of oxygen. If, then, it be true, as above shown, that alcohol possesses the power of preventing the constituents of the blood from being properly oxidized, and thereby fitted for the purposes of nutrition, it is easy to account for its producing a chain of more or less well-marked neurotic symptoms terminating at last in coma and death.—*Abridged from the London Lancet.*

It is urged in behalf of Antarctic exploration that it will promote a needed extension of our geographical and geological knowledge; will contribute to a solution of the question of a connection of the volcanic disturbances in the Sunda Islands and New Zealand along a "weak line" with the volcanoes of Victoria Land; will aid in determining whether any secular climatic change is in progress; and may be the occasion for resuming the magnetic survey of those parts and comparing the results with those obtained by Ross.

A STUDY OF THE AINU OF YEZO.

By J. K. GOODRICH.

FOR many years I have been very much interested in the Ainu * of Japan and Saghalien, and have read carefully everything upon which I could lay my hand containing information about them. Finding that Mr. Batchelor says, "Miss Bird's remarks upon the Ainu are perhaps the best that have been written in English," † I came to the conclusion that anything like a satisfactory knowledge could only be obtained by visiting, as she did, some of the Ainu villages of Yezo. My desire to see them for myself has always been stimulated by the rather conflicting statements about them which are found in different books, and I have always had a sort of a forlorn hope (as I thought it) that fortune would some time turn me back to the shores of Asia, which I left nearly twenty years ago.

This long-wished-for opportunity has at last been granted. I landed in Japan the second time in the spring of 1886, and after waiting only long enough to get a slight working knowledge of the language, I spent a good part of the summer of 1887 in roaming about the northern parts of the empire, and have been permitted to see, live with, and study the Ainu in their homes. The Japanese officers have made special efforts to afford me facilities, and have enabled me to do much more than I could have done without their aid in so short a time.

I have learned of the Ainu history, of their habits and customs, of their myths and superstitions, from *the* man in Japan who is admitted to know this people better than any other person; and I here wish to thank the Rev. John Batchelor, Church Missionary Society, Hakodate, for his kindness, and for the patient way in which he submitted to my cross-questioning; for the advice he gave me how to make the best use of the limited time at my disposal, and for the assistance he rendered in making what is at the best a rough, hard trip as easy as possible. To Mrs. Batchelor my thanks are due for creature comforts which supplemented the trying fare of Japanese inns most acceptably.

I do not hesitate to say that all the *valuable* information contained in these notes has come originally from Mr. Batchelor; and that I have only confirmed what he has told me by my own observation, or by questioning the people themselves, when I found some who understood Japanese. Perhaps it would be

* I adopt the spelling of the name which the Rev. Mr. Batchelor favors, as I yield precedence to him in all matters of exact knowledge concerning this people.

† "Unbeaten Tracks in Japan," by Isabella L. Bird.

better for me to leave Mr. Batchelor to tell his own story about the Ainu, but a missionary who is working single-handed (practically) over the extent of territory which he is trying to cover, can have but little time for ethnological work, and one wonders how Mr. Batchelor has managed to put together even the few stray bits that have come from his pen.

In the villages of the southern and eastern coasts of Yezo, nearly all the men (and many of the women and children) speak Japanese well. Hence it is always easy to get information from them; but, though deserving in a large measure their character for honesty and truthfulness, the Ainu have become sufficiently civilized to thoroughly love "taking a rise" out of a stranger—and if a bit of a lie will make the inquisitive one's eyes pop open and his pencil and note-book spring into unusual activity, the "gentle, truthful savage" is not going to spoil a good story by sticking to dry facts.

In the extreme northern and northeastern coasts of the island, and in the mountain fastnesses of the interior, there are still some villages of Ainu (not great numerically, but preserving their integrity) in which the people have quietly but firmly resisted Japanese advances and civilization. In those places many of the inhabitants can not speak Japanese. They use a few household utensils of Japanese manufacture, but, with this exception, continue to live as much as possible as they did before they came into contact with the Japanese. This seclusion can not last long now, however, for the Japanese are pushing their way slowly but surely (and of late it may be said *kindly*) into every nook and corner; establishing police stations and customs barriers, and fast breaking down the last trace of distinctive lines between the two races. There is a marked difference between—what I may call—the civilized and savage Ainu, and therefore he who would see something of them in anything like their natural condition must come quickly.

It is not my present purpose to discuss this people exhaustively, but merely to present a brief ethnological sketch of them in such a form as may be found interesting to the general reader, which may serve as a skeleton for me or some one who may have time and opportunity to deal with the subject thoroughly, to fill out in the near future.

There are very few tribes remaining on the earth who are as interesting in themselves as the Ainu; and none, perhaps, about whom so little can ever be known. Without a literature, without any monuments or reliable records, dreading to speak of the dead or the acts and deeds of their ancestors, they must be taken as they are, and speculation as to what they have been will always be more or less unsatisfactory.

Their number can not be given with the least degree of satisfaction. The Japanese Government census is not correct, nor is it claimed to be. Individual estimates range from 15,000 to as high as 50,000, but I fancy 16,000 or 18,000 would be about the number of Ainu in the empire of Japan. It is rather satisfactory to learn, from those who have been among the Ainu of late years, that they are holding their own, if not actually increasing in population. They may have survived their usefulness, though it is not easy to say just what that usefulness has been; but the same reason for alleging that they now but cumber the earth can not be advanced in their case that has been charged against the North American Indians (with whom the Ainu have been compared, though upon what grounds I can not see). The Indian is naturally a bloodthirsty savage, while a more peaceful, law-abiding race than the Ainu can not be imagined. In my general opinion of the Ainu I hold a middle ground between Miss Bird's enthusiasm, which makes him a gracious courtier, and the contempt of most Japanese who say, "The Ainu are just dogs, and have no souls."

The people know themselves as Ainu—*Ainu utara*. *Ainu* is singular, and *utara* is a plural suffix: Ainu, however, is often used when speaking of them collectively. Inasmuch as the Japanese word for dog is *inu*, there is some ground for supposing that the tradition concerning the Ainu descent from a "large white dog" was invented by the Japanese after they became acquainted with the Ainu name for themselves, and was intended to show the contempt of the conquerors for the "vile and ignominious Aino." I do not venture to express any opinion as to the origin of this race of people, since it is a subject about which they themselves know nothing for certain. Batchelor says: "The older Ainu have a tradition to the effect that a person named *Okikurumi*" (who is strongly suspected to have been none other than the Japanese hero *Yoshitsune*—J. K. G.) "was the true Ainu ancestor. He descended from heaven to a mountain in Piratoru many years before the Japanese knew or were known by the Ainu. Okikurumi had a wife who was called *Turesh*, and who is always known by name—Okikurumi Turesh Machi. Okikurumi Turesh Machi bore a son, whom they called *Wariunekuru*, and from Wariunekuru the Ainu are said to be descended. Some of the Sara Ainu say that their forefathers came from the islands which lie to the northeast of Karafuto, or Saghalien, meaning thereby the Kurile Islands. The Kurile-Islanders are said to be 'quite as hairy as the bear,' and this accounts for the hairiness of the Ainu."

I think that the character of the Ainu house would seem to indicate that the people are of southern origin, and have been

pushed toward the north by the aggressive, disciplined Japanese. Plainly they have not been very long inhabiting the island of Yezo, for the traces of their predecessors are too clearly to be seen; and all signs seem to indicate that at a not very remote period they were spread over the whole of Japan: it is certain that within the Japanese historical period they were as far south as the latitude of Nikkó in sufficient numbers to be deemed dangerous. Now, every feature of the Ainu hut points to a southern —one might almost say tropical—origin. The frame is made sufficiently strong to resist a heavy gale of wind, but not to carry a stout weather-boarding or a *light,* substantial roof. It seems to me that the original design of the thick, well-laid thatch was to turn a tropical rain, and that the exigencies of environment have produced a certain change and added strength to carry the weight of snow. Had the Ainu come from the north or northwest, it is probable that they would have brought with them a style of architecture adapted to a rigorous climate; that the roof would have been light but strong, and the walls sufficiently thick to break the force of the gales which are known to sweep over the regions of northern Asia. One of the strongest evidences that the Ainu hut is of southern rather than northern origin is the light, thin wall. In this respect it closely resembles the habitation of the East Indies. The low, overhanging eaves is another indication which supports this opinion. The Ainu have never displayed imitative powers, or even the faculty of adapting themselves to their surroundings; hence it is not surprising that they have chosen to accustom themselves to withstand the cold instead of remodeling their habitations.

Another argument to be adduced in support of the opinion that the Ainu are of southern origin is the fact that the girls mature early. I was unable to get any reliable statistics on this point, and depended upon my own observation and that of others. The climate of Yezo, and indeed of all of Japan—with the possible exception of the southern part, the island of Shikoku, for example—is not sufficiently hot to cause the early maturing which is *conspicuous* among the Japanese, and *noticeable* among the Ainu. In Japan, mothers of fourteen are by no means uncommon; and, although the Ainu women do not usually marry before they are probably sixteen or eighteen, they are fitted for maternity long before that age.

Warfare was most irregular with the Ainu. In the case of internecine strife the village chief was the nominal commander, but every person who took part in the engagement conducted his battle after his own fashion. In fights between villages men engaged against men, women contended with women, and even children did battle with children. Internal warfare was not

characterized by the wholesale butchery and merciless slaughter of women and children that is usually so marked a feature of savage warfare. In a foreign war—e. g., against the Japanese—the chief of Sara, who was the recognized head of the nation, assumed command of all the combined forces, the village chiefs acting as colonels. But the utter want of discipline militated heavily against the Ainu, and this undoubtedly was one of the leading causes of their defeat, numbers being a secondary consideration. With the greater strength and superior power of endurance of the Ainu, had they been drilled in concerted action by skillful officers, such as the Japanese generals have been since the time of authentic history, and taught to make the most of their numbers, it can hardly be doubted that they would have made a much better showing than they did.

The language of the Ainu is entirely different from the Japanese. Many "click" sounds are heard, and it is much more consonantal, and there seems to be much less objection to the consonant ending of a word, which is so cordially hated by the Japanese. In the use of pronouns the Ainu language would be considered as philologically in advance of the Japanese, as they are used to indicate the antecedent or person in many instances where Japanese would leave the determination of the person speaking, spoken to, or spoken of, to the context and to the form of the verb. Honorific and humble forms of the verb are not used. The emphasis is similar to that of Japanese; intonation does not always convey the same shade of meaning—that is, interrogation, exclamation, etc.—as in English, although stress is often indicated by an explosive sound.

The tone of voice is always lower and more musical than that of the Japanese, and in the case of younger women is really quite pleasing. One peculiarity of the speech of women is a drawing out of the final vowel of words ending in *a* or *e*. At times this approaches the long *a-a-h* or *e-e-h* of a contented little baby.

The Ainu have been called the hairy people, and, contrasted with the Japanese, the name is well given; still, I could not find any of the animal-like pelts I had been led by some authors to expect to see. The men have heavy, coarse shocks of black hair on the head, cut off short behind across the nape of the neck, and allowed to grow nearly to the shoulders on the sides, being roughly brushed to either side from the forehead. Their beards are very strong and quite long, being allowed to grow without restraint. Most of them have "mossy breasts," and a few have a furry growth on the shoulders and down the back, but not more than I have seen on the shoulders of coolies in the south of China; while for hairy growth on legs and arms, I have seen Caucasians as well covered as any Ainu that *I* saw.

In stature they are rather under the average of the Caucasian, nor do they seem to be as tall as the southern Japanese, but upon this point I am not prepared to make any positive statement, as I took no measurements. Batchelor says: "Their men would measure about five feet seven inches in height. . . . Their foreheads are high, and the facial angle measures about 70°." I can not but think this is rather taller than the average; for one young man who seemed quite a giant among his fellows could not have been more than five feet eight inches in height. Their proportions are good, and the men are both stout and squarely built, the whole appearance being rather more attractive than that of the Japanese of the same relative standing. Their attractiveness, however, does not tempt one to anything like familiarity, as in their personal habits they are the very personification of dirtiness. Washing of person or clothing for the sake of cleanliness never seems to be considered of the slightest importance to them. In warm weather the younger people are tempted to cool off a bit by bathing and swimming in the rivers or salt-water estuaries near the villages; but, during all of my experience (and this is fully confirmed by the statements of others who have had longer knowledge of them), I never once saw a man or a woman performing anything like ablutions in an Ainu village. When brought under civilizing influences, they adapt themselves to their environment, and make very good servants.

An old custom of the people forbids an Ainu woman exposing her person in any way. Some go so far as to say that they must not be unclothed even in private. Consequently, the girls whom I saw in bathing wore their cotton gowns, cut in the shape of a shift, while the boys were without clothing of any kind, though some of them wore amulets (of Japanese origin) tied around their necks.

I was particularly struck by the shapeliness of the Ainu limbs and extremities. Some of the women had small hands and feet, attached to well-turned wrists and ankles, whose symmetry and delicacy of shape dirt could not hide. The color of the skin seems to be darker than that of the Japanese, but just how much of this is due to exposure, and how much to their antipathy to water and utter ignorance of soap, it is impossible to even guess.

The face is round and broad, and although it is lacking in length as a rule, yet in many instances the chin is not badly shaped; the lips are large without being disgustingly gross; the eyes are dark-brown in color, and rather larger than those of the Japanese, without any drooping of the inner corner of the upper lid, and hence appear to be straight, without any of the obliquity which characterizes the Mongolian eyes; the cheek-bones are

high, but not specially prominent; the nose is usually large, and, in the men, oftentimes indicates a strength of will which is not confirmed by the character of the people; the forehead is high and broad, sometimes overhanging to such a degree as to intensify the apparent lowness of the base and bridge of the nose, and I think this fact has led most observers to overlook a certain shapeliness of that member. The faces of the men impress one with their appearance of dignity, the long hair and the flowing beard giving them a truly patriarchal look. When in repose the face is apt to have an appearance of sadness, for the eyes—except when hunting or aroused by some momentary excitement—are rather dull and expressionless. This appearance of sadness is particularly noticeable in the younger people and children, but it is very evanescent, and disappears instantly when anything is said or done in the least likely to provoke a laugh; then the face breaks into smiles, and presents a singularly attractive aspect. Though naturally as shy as a young fawn, even the little children will respond with a laugh to a kind word and smile from a foreigner. I do not understand their language at all, and therefore can not speak authoritatively, but I do not think that I was ever called by foul names in an Ainu village. One can usually tell by the tone and manner, and the reception of the insult by others, whether or not opprobrium is being shouted after one. I can not say the same of all the Japanese places I have visited.

The robustness and general physique of the Ainu may be due to the fact that—so far as known—they have always eaten meat freely; whereas their neighbors and conquerors, the Japanese, have been practically vegetarians for many centuries—fish, a little fowl, and rarely a bit of game, not being a sufficient compensation for the absence of solid flesh from their regular diet.

No exact idea of the shape of the Ainu *men's* heads can be formed from their appearance, for the hair forms a heavy shock, standing out all around; but when the *women's* hair is dressed, their heads seem to be rather small and shapely, and well set on necks which are often long and graceful.

The women certainly have larger hips than the Japanese women. This may be due to their never having used the tight dresses, with the strong under-bands and enormous belts (*obi*) which are swathed around the Japanese girl when she is yet very young. In freedom of motion, in elasticity of gait, and in grace of carriage, the Ainu woman, with all her dirt and rags, is in pleasing contrast to the awkwardness of her Japanese sister in purple and fine linen!

Almost the first thing to attract the attention of a stranger visiting an Ainu village is the tattooing around the mouth of

the women and girls. At the first glance one is deceived into supposing that the *young men* wear very delicate mustaches and train them carefully! As there are no written records of any kind among the Ainu, no means of communication except oral, it is impossible to get at anything like a satisfactory explanation of this curious and thoroughly disfiguring custom. The people themselves say that they adopted it from the people whom they found in possession of the land (Yezo) when they came to the island *from the West* (*?*). Those people, the *Koro-pok-guru,* they say were smaller than themselves, and were very soon and easily subjugated; but, evincing a kindly disposition, and a desire to affiliate with the new-comers, rather than to continue to wage war upon them, they (the Ainu) met their overtures half-way, ceased to fight them, and adopted some of their customs, one of them being this curious tattooing. The process commences when a girl is about ten years of age. A woman makes a number of small cuts with a sharp knife on the lips and around the mouth, deep enough to cause the blood to flow freely. With some of the blood, and soot obtained by catching on the bottom of an iron pot, or anything else which may come handy, the smoke from burning birch-bark, a paste is made and well rubbed into the incisions. After the resulting inflammation has subsided, a number of blue marks are seen, and the process is continued until the girl becomes a woman, when the mouth presents the appearance of being surrounded by a growth of hair trained into the dainty mustaches of a most consummate dandy. The tattooing around the mouth covers about one half of the lips, so that when the mouth is closed they appear of rather a sickly color. In the mean time the tattoo-marks have been applied to the forehead, and a heavy line drawn just over the bridge of the nose to connect the eyebrows (which are not shaved off, as *was* the universal custom among the married women of Japan),* and on the back of the hands and up the forearm to the elbow in a rude geometrical pattern.

Although the Ainu now use Japanese cotton and hemp as materials for clothing whenever they can get them, they still are compelled, at times, to resort to the material called *attush.* This is "the inner bark of a kind of elm, possibly *Ulmus montana* of Franchet and Savatier's catalogue of Japanese plants, generally known in Yezo as *Ohiyo,* but the true Ainu name of which is *At-ni,* attush meaning 'elm-fiber.'" It is thoroughly hackled, then spun (or drawn out into strands), and afterward

* This custom is rapidly disappearing from the neighborhood of the treaty ports, and to some extent in the interior, as is also the still more disfiguring sign of a married woman, viz., the blackened teeth. With them are going the short queue and partly shaved head of the men.

woven with a small hand-loom, which is held by the toes and a cord passing around the body. This loom is a very rough affair, but in all essential parts is similar to the hand-loom still to be seen in parts of the United States. The cloth is very rough and hard, but extremely durable. The piece is narrow, but just suited to the one pattern of outer garment worn by men and women alike: this is something like the Japanese *kimono,* but higher in the neck, and has more shapely sleeves. It is a long, perfectly straight gown, reaches nearly to the feet, folds across the body, and is secured at the waist by a girdle similar to the Japanese *obi,* but much narrower and nothing like so elaborate. The Ainu are very fond of ornamenting this gown with broad stripes of blue cotton cloth (an inch or two wide), stitched on in geometrical figures with thread, which makes a contrast: these figures are usually put on the front corners, around the neck, on the yoke, and on the sleeves. A burial-robe, which I saw in the Ainu collection of the Satporo Museum, was made of the attush, tan-colored, and ornamented with stripes of Turkey-red (an inch and a quarter wide), stitched with black, and with dark-blue cotton cloth stitched with thread of a lighter shade. The design was straight or at right angles, only one or two slightly curved lines appearing in a most intricate pattern.

The durability of the Ainu coat, with a certain attractiveness about the trimming, makes it quite popular with the Japanese, and as soon as one lands on the island of Yezo the Ainu styles are seen. The sleeves of this coat are much more sensible than those of the Japanese, which are long and constantly flapping about the legs, whereas the Ainu fits rather snugly about the wrist. Like the Japanese, the Ainu married women wear an under-garment, or smock, of cotton cloth; usually this is merely a straight piece of cloth folded around the waist and loins. In winter the Ainu wear skin-clothing, and leggings and boots made of deerskin; the coast Ainu make boots of salmon-skin.

Girdles—or obi—are made of attush or elm-fiber. A woman's obi, which I have, is made of hemp. It is eight feet long and only two inches wide, coarsely woven of large thread, with narrow, dark-blue stripes on the edges and half-way between the edges and middle, and one broader stripe in the center with a light-blue median line. Near each end is a little bit of red as an added ornament. The Karafuto (Saghalien) Ainu women wear girdles made of leather, and ornamented with rings and Chinese *cash,* which they probably get from Mantchooria. The Ainu do not protect their heads and feet at all, except during the winter.

One of the most common things seen in an Ainu village is the *tara,* or strap used for carrying all manner of bundles, and

even children. It is made from attush, the same material as was formerly used altogether for their clothing. One in my possession is eight feet long. The bark has been roughly hackled, and in the center of the strap is braided into four strands, the outer ones three quarters of an inch wide, being about twice the width of the inner ones. Just at the middle for five inches these are caught together by a cross-weaving of blue and white cotton yarn, in a regular lozenge pattern; this is the part which is placed over the forehead when carrying a load. About seven and a half inches from this, toward each end, the four strands are brought together into a round, double strand, by a seizing which crosses itself regularly. This seizing extends for nearly four inches, and then the braiding is continued in a single flat plait for about eighteen inches, when it runs out into frayed ends. In using, the bundle is slung upon the back, the broad part of the tara being brought over the forehead, so that, while the back bears the weight, the forehead keeps the bundle in place.

DARWINISM AND THE CHRISTIAN FAITH.

II.

UP to the point at which we have arrived, a churchman, in accepting Darwinisn, finds no real difficulty. It neither gives nor suggests an alternative for God's primary creation of the world. And though in the "origin of species" it does not offer an alternative for "special creation," a Christian is only called upon to abandon a theory recently admitted into theology for one which is not only soluble in the Christian view of creation, but on grounds both scientific and theological is more in keeping with what we know of God in his present working. Those who have followed the argument of a previous paper will admit Prof. Huxley's statement, that, so far as the "origin of species" is concerned—

> Evolution does not even come into contact with theism, considered as a philosophical doctrine. That with which it does collide, and with which it is absolutely inconsistent, is the conception of creation which theological [*Quaere* scientific?] speculators have based upon the history narrated in the opening of the book of Genesis.

We are prepared even to go further, and to say not only that theism does not lose, but that it actually gains by the exchange. If Darwinism has destroyed the "dogma of special creation," it has destroyed a "dogma" which was a scientific, or rather unscientific, theory, and from which Christianity, like science, should be glad to shake itself free.

3. But the doctrine of natural selection is said to have destroyed the argument from design in Nature. This is a much more serious matter. For a Christian is bound to believe that Nature is the work of an all-wise and beneficent Creator, whom he also believes to be almighty, so that the Christian can not accept the view adopted by Mr. J. S. Mill, and make a division of labor or of territory between God and a power which limits and thwarts him. We propose to state the difficulty here as clearly and as strongly as we can, because we believe that it is the difficulty which presses most heavily upon thinking men at the present time. In the case of Mr. Darwin himself we notice that, while the substitution of derivation for special creation seems even to have strengthened his belief in the grandeur of creation, the substitution of natural selection for Paley's teleology cut away the main argument for believing in a God at all.

We are not surprised, then, to find those who are at least in imperfect sympathy with Christianity rejoicing in the discomfiture of the theologians. Mr. G. H. Lewes's pæan of triumph, in the "Fortnightly" of 1868, is perhaps the *locus classicus* for this view. Prof. Huxley, with ill-concealed exultation, tells us that what struck him most forcibly on his first perusal of the "Origin of Species" was "the conviction that teleology, as commonly understood, had received its death-blow at Mr. Darwin's hands."* Haeckel, in the same strain, says,† "Wir erblicken darin den definitiven Tod aller teleologischen und vitalistischen Beurtheilung der Organismen"; and in his "History of Creation,"‡ "I maintain, with regard to the much-talked-of 'purpose in Nature,' that it really has no existence, but for those persons who observe phenomena in animals and plants in the most superficial manner."

From the insolent dogmatism of Haeckel, and the anti-theological *animus* of Lewes and Huxley, it is refreshing to turn to the cautious and reverent utterances of Charles Darwin. In his letters we are able to trace every stage through which he passed on this question. At Cambridge, *circa* 1830, he read carefully and with "much delight" Paley's "Evidences" and his "Natural Theology," and speaks of the reading of these books as the only part of the academical course which was of the least use in the education of his mind,# but he "did not trouble about" Paley's premises—i. e., he took the existence of God as a personal being for granted. Later on, apparently between 1836 and 1839, though he still "did not think much about the existence of a personal God," he abandoned Paley's view, and never returned to it:

* "Lay Sermons."

† "Generelle Morphologie," i, p. 160.

‡ Vol. i, p. 19, English translation.

"Life and Letters," i, p. 41.

The old argument from design in Nature as given by Paley, which formerly seemed to me so conclusive, fails now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows.*

An incidental allusion, in a letter of 1857,† shows that he had come to look upon a belief in design and a belief in natural selection as alternatives, and mutually exclusive. But here Darwin began to realize the contradiction in which he was involved. On the one side his theory was opposed to Paley's, on the other it was saturated with teleology. "The endless beautiful adaptations which we everywhere meet with,‡ the extreme difficulty, or rather impossibility, of conceiving this immense and wonderful universe, including man with his capacity of looking far backward and far into futurity, as the result of blind chance or necessity,"# the fact that "the mind refuses to look at this universe, being what it is, without having been designed"‖—these had to be set off against "the difficulty from the immense amount of suffering,"△ and the *a priori* unlikelihood that an omniscient Being should have willed the world as we know it. In 1860, the year after the publication of the "Origin of Species," Darwin had reached the stage of utter bewilderment:

I grieve to say [he writes to Asa Gray] that I can not honestly go as far as you do about design. I am conscious that I am in an utterly hopeless muddle. I can not think that the world, as we see it, is the result of chance; and yet I can not look at each separate thing as the result of design.◊

And in an earlier letter of the same year he says:

I am bewildered. I had no intention to write atheistically. But I own that I can not see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I can not persuade myself that a beneficent and omnipotent God would have designedly created the *Ichneumonidæ* with the express intention of their feeding within the living bodies of caterpillars, or that a cat should play with mice. Not believing this, I see no necessity in the belief that the eye was expressly designed. On the other hand, I can not anyhow be contented to view this wonderful universe, and especially the nature of man, and to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance. Not that this notion *at all* satisfies me.‡

Elsewhere he says of this suggestion, "I am aware it is not logical with reference to an omniscient Deity."↕

* "Life and Letters," i, p. 278. † i, p. 478. ‡ i, p. 279. # i, p. 282.
‖ i, p. 283. △ i, p. 276. ◊ ii, p. 146. ‡ ii, p. 105. ↕ ii, p. 247.

It was immediately after the publication of the "Origin of Species" that Darwin set about his work on orchids, in which, more than in any other of his writings, the notion of purpose is prominent; and some ten years later we find him gladly recognizing the inherently teleological character of evolution, which had been pointed out in a review by Dr. Asa Gray. Dr. Gray had written:

> Let us recognize Darwin's great service to natural science in bringing back to it teleology; so that instead of morphology *versus* teleology, we shall have morphology wedded to teleology.

Darwin writes back:

> What you say about teleology pleases me especially, and I do not think any one else had ever noticed the point. I have always said you were the man to hit the nail on the head.*

Here we are brought face to face with the paradox which had been puzzling Darwin. The theory, which destroyed Paley's doctrine of design, or the old teleological doctrine, unconsciously introduced a new teleology. And the gradual recognition of this new fact is alike curious and instructive. In 1864, when the "Origin of Species" had been four years, and the "Fertilization of Orchids" two years, before the world, Prof. Kölliker, an advanced evolutionist, and a strong opponent of final causes, accuses Darwin of being "in the fullest sense of the word a teleologist," and adds that "the teleological general conception adopted by Darwin is a mistaken one."† Prof. Huxley answers Kölliker, and, in defending Darwin, is driven to distinguish between the teleology of Paley and the teleology of evolution. Two years later, in 1866, appeared the Duke of Argyll's "Reign of Law," in which Darwinism was claimed on the side of the doctrine of design; and the next year Huxley, again in criticising a German professor, Haeckel, and his repudiation of teleology, published the remarkable review, some pages from which reappear in the chapter he contributes to Darwin's "Life and Letters,"‡ and which has more than once been quoted in this connection:

> The doctrine of evolution [he says] is the most formidable opponent of all the commoner and coarser forms of teleology. But perhaps the most remarkable service to the philosophy of biology rendered by Mr. Darwin is the reconciliation of teleology and morphology, and the explanation of the facts of both, which his views offer. The teleology which supposes that the eye, such as we see it in man or one of the higher vertebrata, was made with the precise structure it exhibits, for the purpose of enabling the animal which possesses it to see, has undoubtedly received its death-blow. Nevertheless, it is necessary to remember that there is a wider teleology which is not touched by the doctrine of evolution, but is actually based upon the fundamental proposition of evolution.#

* "Life and Letters," ii, p. 367.

† Quoted in "Lay Sermons," pp. 329, 330.

‡ i, p. 554.

"Critiques and Addresses," p. 305.

Haeckel's denial of teleology is thus shown to prove too much. And the appeal to rudimentary organs against teleology, Huxley points out, places the evolutionist of that day in a dilemma:

> For either these rudiments are of no use to the animals, in which case . . . they ought to have disappeared; or they are of some use to the animal, in which case they are of no use as arguments against teleology.*

We can hardly be wrong in assuming that Dr. Asa Gray had this review of Huxley's in his mind when he spoke of—

> The great gain to science from Mr. Darwin's having brought back teleology to natural history. In Darwinism [he adds] usefulness and purpose come to the front again as working principles of the first order; upon them, indeed, the whole system rests.†

Is there, then, no difference between the old and the new teleology? Is the old argument rehabilitated? Can we say here, as in the triumph of derivation over special creation, that the Christian faith loses nothing and gains much? We are by no means prepared to defend this paradox. The old and rapid argument from Nature to an omnipotent and beneficent Author was never logically valid. To a thinking man its death-knell was sounded by Kant long before the death-blow was given by Darwin. In spite of the reverence with which Kant treats an argument, which he speaks of as "the oldest, the clearest, and most in conformity with human reason," he sees that the very most which could be established by it would be the existence of "an Architect of the world, not a Creator." It must fall very far short of its proposed aim—viz., to prove the existence of an all-sufficient original Being.‡ Modern science has only brought out in its own way and for ordinary people a truth which metaphysicians already knew—viz., that the argument was, as Dr. Gray puts it, "weighted with much more than it can carry. . . . The burden which our fathers carried comfortably, with some adventitious help, has become too heavy for our shoulders."# The older teleologists noted certain favorable instances, and based on them an argumentative structure which the foundation was quite insufficient to sustain; while, if instances of apparent meaninglessness or misery were adduced, they were put on one side with *Dieu le veult.* In the present day a Christian, whether he is an evolutionist or not, has to run the gantlet with an army of facts and arguments of which his forefathers knew nothing. No intelligent man could now write as Paley does:

> It is a happy world after all. The air, the earth, the water teem with delighted existence. In a spring noon, or a summer evening, on whichever side I

* "Critiques and Addresses," p. 308.

† "Darwiniana," chap. iii.

‡ "Critique," Max Müller's translation, p. 535.

\# "Darwiniana," p. 374.

turn my eyes myriads of happy beings crowd upon my view. "The insect youth are on the wing." Swarms of new-born flies are trying their pinions in the air. Their sportive motions, their wanton mazes, their gratuitous activity, their continual change of place without use or purpose, testify their joy, and the exultation which they feel in their lately discovered faculties. . . . The whole winged insect tribe, it is probable, are equally intent upon their proper employments, and under every variety of constitution, gratified, and perhaps equally gratified, by the offices which the Author of their nature has assigned to them.*

The Christian of to-day believes, no less firmly than Paley did, that God is omnipotent, and that God is love. But the old *couleur de rose* view of Nature is no longer possible. "Destruction is the rule; life is the exception." The waste is enormous; the suffering terrible. The many perish; the few survive. All down the scale of sentient being, "perfected by suffering" seems written in unmistakable characters. The law of God's work in Nature is indeed *progress*, but progress at a tremendous and, as it seems to us, reckless cost. These are facts for which neither evolution, except incidentally, nor any other theory of Nature, is responsible. But they are facts of which any theory, theological or scientific, must now take cognizance. They are as fatal to the old teleology of Paley as the facts of embryology are to the theory of independent creations. We may still reverently say, "It is God's will," but that is only an admission that we can not explain the facts, or justify them to the reason or the conscience. It may be a necessary, as it certainly is a devout, attitude of mind, but there is in it an undertone of despair.

Evolution is not responsible for the problem. Can it help us in the solution? The old teleology was destroyed by the new facts, and Darwin offers us a deeper and wider view of purpose based upon these facts. We used to start with the assumption that everything exists solely for the good of man. And though we expressed our belief in an all-wise and beneficent Creator, our teleological inquiries would sometimes take the unsubmissive form of *Pourquoi Dieu fait-il tant de mouches?* (Why did God make so many flies?) a question which was popularly supposed to merge itself in that of the origin of evil. The new teleology proceeds differently. It seeks to give a reason for the existence of each species, by fitting it into its place in the genealogical tree, and relating all the species to one another in the unity of the whole. As Asa Gray puts it:

The forms and species, in all their variety, are not mere ends in themselves, but the whole is a series of means and ends in the contemplation of which we may obtain higher and more comprehensive and perhaps worthier, as well as more consistent, views of design in Nature than heretofore.†

* "Natural Theology," pp. 370, 371.

† "Darwiniana," p. 378.

So in the case of organs, we believe that "organs have been formed so that their possessors may compete successfully with other beings and thus increase their number."* We fearlessly then ask, in reference to each part, What is its use? And if it is of no present use, we do not say, "The Creator put it there for symmetry, or as part of a plan," but we ask, What meaning has it had in the past? How can we relate it with by-gone if not with existing conditions? If *ontogeny*, the history of the individual, gives us no answer, we fall back upon *phylogeny*, the history of the race. Organs, which on the old theory of special creations were useless and meaningless, are now seen to have their explanation in the past or in the future, according as they are rudimentary or nascent. There is nothing useless, nothing meaningless in Nature, nothing due to caprice or chance, nothing irrational or without a cause, nothing outside the reign of law. This belief in the universality of law and order is the scientific analogue of the Christian's belief in Providence. And, as Prof. Huxley admits, it is an "act of faith," *brought to* Nature, and slowly, and as yet only in part, verified *in* Nature. Yet to doubt that Nature is everywhere rational, and therefore intelligible, would be for a scientific man an act of intellectual suicide.

But if we believe in law and order everywhere in Nature, though there is so much which is as yet hopelessly irreducible to law, and if that belief is read *into* Nature long before we can read it *in* Nature, may we not approach the moral difficulty in the same spirit? For there is here a curious parallel. What our rational nature resents is not the existence of facts which *we* can not explain, but of facts which *have no* explanation; and what the moral nature rebels at is not suffering and pain, but needless—i. e., meaningless—pain, suffering which might have been avoided. And here Darwinism gives us a hint, if it is but a hint: "Natural selection works solely by and for the good of each being."† The arrangement of the world is "generally beneficent,"‡ and "tends to progress toward perfection." But then—

> Without the competing multitude, no struggle for life, and without this no natural selection and survival of the fittest, no continuous adaptation to changing surroundings, no diversification and improvement leading from lower up to higher forms. So the most puzzling things of all to the old school of teleologists are the *principia* of the Darwinian.#

It is no final solution of the difficulty, and yet man, who is so wise and good that he is always saying with King Alphonso of Castile, "If God had called me to his councils things would have been in better order," has invented competitive examinations,

* "Life and Letters," i, p. 280. † "Origin," p. 428. ‡ i, p. 279.
# Asa Gray, p. 378.

which mean suffering and pain for all, without even a compensating "survival of the fittest" or improvement of the race!

To sum up thus far. One who believes in the God of Christianity is bound to believe that creation is his work from end to end, that it is a rational work and the work of a being who is wholly good. He is bound to believe that "God's mercy is over all his works," that "not a sparrow falls to the ground" without his knowledge, that there are design and purpose everywhere. But he is not bound to know or to say that he knows what that purpose is, or to show that marks of beneficence are everywhere apparent. Still less is he bound to assert, as the old teleology did, that he can demonstrate the wisdom and goodness of God from Nature alone. Evolution starts with an "act of faith," a postulate of our rational nature—viz., that everything is rational and has a meaning, even that which is at present irreducible to law. In this belief much which was once meaningless becomes intelligible, and a scientific man's faith is not staggered by the fact that much as yet remains outside, which science has not explained. On the moral side also we start with an "act of faith," a postulate of our moral nature, that God is good and can not be the cause of meaningless and unnecessary pain. And our faith is not staggered by much which seems, as yet, like useless suffering. Even if Darwin's mature judgment that on the whole "happiness decidedly prevails" were not true, we should still believe in the goodness of God, in spite of all that seems to contradict it, and look forward to the time when our children, or our children's children, will see clearly what to us is dim or dark. —*The Guardian.*

THE GEOLOGICAL TOURIST IN EUROPE.

By ALFRED C. LANE.

NINETY thousand Americans go abroad every summer. Among this army there must be many readers of this magazine, who are interested not only in art but in science; who find time to wonder, as they toil up to the top of Cologne Cathedral, what the stone is that sustains so mighty a mass, and whence come the crystals that now and again flash from the walls; who, as their eye roams over the vast expanse seen from above, let their imagination roam into the past when the Rhine had not yet won from the sea the provinces over which it now meanders. The artist finds guide-books crammed with catalogues of museums containing works of man and critical notices of the same, and man's battle-fields and burial-places are noted. Yet the collections of natural wonders are so curtly mentioned

as to be easily overlooked, while the hidden forces producing the landscape that the artist depicts, the battle-fields of Nature, and the burial-places of conquered and conqueror alike in the struggle for existence, are rarely noticed.

The proportion of scientific men that go abroad is not small. How much greater the number of amateurs! How naturally do college students pass from the attached life of lecture-room and laboratory, floating off into the free life of travel! Where better can they go than to Europe, where they can learn the languages, the keys to the various chambers of scientific knowledge, and where roads and inns are so good and abundant? Although Europe is not the pattern of the world, yet most of our geological theories have been founded on European facts, and it is easier to see where a theory does not apply after seeing where it does.

Notes of some of the more satisfactory of my excursions, arranged more or less continuously, may not be useless, therefore, especially if accompanied with a few references. I know that three years ago I would have given five dollars for such an article. Of course, my sketch must follow the line of my studies. Another would doubtless wish to give Kew Gardens, the Jardin des Plantes, and the zoölogical station at Naples more place; but if the imperfections of this article should cause some one else to satisfy the crying need of a set of scientific guides, I would be content. Even if it only leads some summer wanderer to buy a geological map or two, and see not only with the eyes but with the understanding also, it will have had reason for being.

Suppose we have escaped the illustrations of the floating-ice theory off Newfoundland, and passed across that hackneyed specimen of an ocean-current, the Gulf Stream, and are about to follow the course of the satchel-guide or some such book through Europe, with limited time.

We land first on the Emerald Isle (13).* Being a glaciated country, the casual observer will not see so much of the great basin of subcarboniferous limestone which the island is, but the bogs due to irregular deposition of drift are a characteristic feature, and we may see the *drumlin*—a word recently borrowed to denote those smoothly rounded hills of compact bowlder clay, formerly called lenticular, so common about Boston. We may also see the Giant's Causeway and Fingal's Cave, illustrations of basaltic jointing. I have from Portrush, not far off, a tephrite obtained by Prof. Carvill-Lewis.

Crossing over the channel, we will not stop to examine the beds of Anglesea, interesting as they are, unless we have plenty of time; yet, if one has it, and is interested in metamorphic rocks, a study of the ground, in connection with past literature,

* The numbers refer to the books at the end.

may help his understanding of that which is to come. If not provided with maps, etc., we had better go at once to London and provide ourselves at Stanford's. While in London we must not fail to visit the Museum of Practical Geology in Jermyn Street, which issues a number of catalogues of permanent value (33), and a geological guide to London, and contains models and collections of all kinds. Every one will admire the polished marbles, granites, and serpentines. If we have a Saturday free, an excursion of the Geologists' Association may attract us. At any rate, we shall notice that London lies in a geological basin, and, if our drinking-water is from some deep artesian well, we may thank our stars that London has such a favored situation as not to be entirely dependent for water-supply upon the filthy Thames. Let us go north. There are three main lines of tourist travel. The most westerly passes by the lake district of Westmoreland and Cumberland. It is curious to note how uniformly that combination of mountain and lake which is most attractive for summer resort occurs where a region of metamorphic rocks has been subjected to glacial action. Lake Superior and Windermere, Maine and Switzerland, all answer to this description. We dare not stop to discuss the reasons. (See 4, chapter xxvii; 10, p. 516.) We shall see the same sort of thing in the Trossachs and Switzerland. If you want to do any detailed work in the region, start in from Keswick, where a museum contains local collections and models.

Scotch surface geology is of the same glaciated type so familiar in America, and those who wish to study the parallel roads of Lochaber, or the Tertiary gabbros of Judd, must turn to the Scotch survey for guidance (3, 5, 13). For us an excursion or two about Edinburgh must suffice. The collections of the Museum of Science and Art are fine, and we can climb the volcanic crags of Castle Hill, Calton Hill, or Arthur's Seat, and wonder what the landscape was like when hot lava rolled down Salisbury crags. At Newhaven, near by, on the shore of the Firth of Forth, the clay ironstone is exposed, and, breaking open the oblong pebbles, you may find a fish, but more likely a coprolite or septarium. If you wish to see more of the Carboniferous and the coal and iron industry, you have only to run down to Gilmerton, near which are numerous coal-mines, and great piles of iron-ore a-roasting. Ganoid scales and teeth are not rare, and are collected by some workmen. The name of one was Joseph Blair, of Loamhead.

On our way south again we shall probably pass through the Peak of Derbyshire and behold the scenery of the subcarboniferous, the great mountain limestone in its most beautiful development, its dewy dells, its steep yet rounded bluffs, and its

innumerable caves. So far as caves are concerned, the formation in Kentucky surpasses it, but its veins of lead and fluor-spar —blue John as it is called—are peculiar to it.

Farther south, near Bedford, the oölites and Oxford clay are well exposed, beds not much developed in our Eastern States, and not far off, near Cambridge, the chalk comes in. The Cambridge greensand, formerly worked for phosphates, is nearly worked out, I believe, but hosts of the charming little ammonites, brachiopods, and crabs that the workings yielded, are stored in the museum, awaiting exchange. In the museum, too, you may learn where the chalk is best to be seen, and whether any recent excursion has probably cleaned the workmen out of all their good sea-urchins. They say that from Cambridge to the Ural Mountains no land rises above two hundred feet, and certainly off toward the fen-land which man has redeemed from the sea it looks plausible. What a change in the geography and politics of Europe a submergence of two hundred feet would cause!

Back once more in London, other excursions invite us (see 2, and the reports of excursions of the various Geological Societies and meetings of the British Association) to the Isle of Wight, or to the Lizard, which is, naturally enough, serpentine. But between so many it is easier to skip them all than make a choice. Let us follow the track of the Geologists' Association to Belgium (14). Reaching Brussels, we find in the Musée Royale near the picture-gallery a magnificent collection, unique in its iguanodons, and finely arranged to illustrate geological excursions. Notice, for example, the section along the Meuse, with illustrative specimens.

In the suburbs of Brussels the work of the builder is continally opening and closing sections in the tertiary sands, but somewhere surely one can see the *grès fistuleux* of the Bruxellien, whose curious columns of sandstone, consolidated around annelid tubes, stand up amid the yet unconsolidated sand. Various nummulite zones occur, but not recent information as to where to pick up these coins of Nature's realm is valueless (compare, however, 14). Shark's and skate's teeth also occur, and occasional crabs. Very close to Calevoet Station I picked up a chunk of half-consolidated sand fairly bristling with teeth. The pamphlet (14) covers the ground so well that I need not dwell on Belgian geology, except to call attention to the agricultural geological soil map (15). Nor does Holland call for particular remark, except that one should not fail to run down to Katwyk-am-Zee from Leyden, or Scheveningen from the Hague to see the mighty dune-bulwarks that protect the land from the storms of the North Sea.

Starting up the Rhine, we shall have passed out of Holland before we leave alluvial soil, and a route which has much more of geologic interest and variety, and is not devoid of beauty and historic association, is to go across the Belgian coal-fields, scenes of the worst European strikes, up the gorge of the Meuse. In passing, I note that the curious porphyroids of Bonney (14) and Renard have been recently blasted into in road-repairing, so that the next comers will have a better chance than for some years before, when the continuous attrition of geologists' hammers had rounded off every corner. At Charleville-Mezières, a typical provincial French town, we stand on the rim of the Paris basin, and *gryphœas* of the Lias abound. Thence, running along the rim of the basin past Sedan, we come to Luxemburg or Metz. Luxemburg is beautifully situated, being surrounded by cañons cut into the sandstone here so typically developed that it is called the Luxemburg sandstone. If we go to Metz, the work of fortification still going on gives good sections in the Jura. Only beware lest you are charged upon by some too vigilant sentry, as a friend of mine was. I escaped by being careful not to have maps or note-books around in sight. However, if attacked, pick up a *cidaris* club and defend yourself manfully. We can go on to Treves, into the Eifel, or down the Moselle, or to Saarbrücken, the great coal-center and first point attacked by Napoleon III, and down the Nahe to the Rhine. Whichever is omitted may also be taken as a side excursion from the Rhine.

Suppose, however, we go straight up the Rhine. We come first to Cologne. Climbing the cathedral, we see off on the southeast the seven blue summits of the Siebengebirge, whence the gray trachyte with sparkling sanidin crystals comes, that lines the winding staircase we have ascended. In the Siebengebirge is the cave of the dragon that Siegfried destroyed, and true it is, according to geologic tale, that once the volcano did cut off the mighty stream that glides in serpentine course beneath our feet. The victory was but for a time, however. Siegfried is dead, and so is the volcano, but dragons and rivers are hundred-headed and immortal, and the Nibelungen gold is still guarded securely. To the Siebengebirge, then, will be our next excursion, and we had best start from Bonn, the famous university town. We can there buy what guides we wish (16), and visit the collections of the Poppelsdorfer Schloss, valuable and beautiful themselves, and especially to us, as they illustrate by models and specimens what we are to see. Some of the rooms are fantastically decorated with bits of satin-spar and shells. Sturz's natural history store, one of the finest and largest—but not the cheapest—in the world, is in Bonn. His polyglot catalogue gives many hints for excursions to the collector.

Along here Baedeker has an unusual amount of geologic notes, and so we pass rapidly on, noting casually the imprints of leaves in the trass of the Brohlthal, and the Laacher See, latest worked upon by an American, L. L. Hubbard. At last we reach Coblentz, from which one division of the Devonian, through which we are passing across the strike, takes its name. Here the valley of the Moselle invites us to take a *détour* into the district of little extinct volcanoes called the Eifel. This is one of the standard geological excursions (16), and in the Whitsuntide vacation of 1886 there met in Gerolstein no less than thirty-five geologists, representing five different German universities, and I dare not guess how many nationalities.

The little inns that are sprinkled through the district are generally good, and well up on the customary mineral localities. This is one of the great regions for volcanic minerals, augite, hornblende, sanidin, olivin, apatite, sodalite, etc. In the neighborhood of Gerolstein abundant Devonian fossils are collected, calceola, gomphoceras, trilobites, and corals. At Gerolstein itself is a dealer in such things at reasonable prices (except for the trilobites). This village is prettily situated, and rejoices in an open fountain of soda-water. These are, in fact, common in the Eifel, the Apollinaris being the most famous, but many others, as Birresborn, are as good. Over against Gerolstein lies a bluff crowned with a massive limestone, once the bottom of a synclinal fold, which reminds one of the text of Isaiah, "Every valley shall be exalted." On our excursion we spent the first night in Wittlich; the village is not near the station, for Continental stations have a way of splitting the difference between two towns which must be well borne in mind by the walker. The next morning we rode on to the Mosenberg, an extinct volcano that has three crater rings very distinct. Coming down, after a *détour* to the Meerfelder Maar that I do not recommend (the meat at the inn was little, but lively), we went on to Manderscheid. Here we had a good dinner at the Hotel Zeus. No doubt our whetted appetites added sauce, but those trout were certainly good.

I know of no spot on earth so romantic as the situation of the twin-castles of Manderscheid. A stream flows in a huge S about two ridges of rock, on which the castles are built, so narrow in places that one could hold a thousand in check. Out along one of these rocks, then steeply down and up—a rough scramble not suited for skirts—we went to Gillenfeld, passing a couple more crater-lakes on the way. Here we stopped the second night. The inn was full, so that I went out to the "pastor's" to sleep. The next morning, in spite of lowering and later pouring weather, we took a *détour* to the Pulver Maar, another lake with-

out an outlet, where sanidin bombs may reward the seeker, and bits of underlying Devonian slate are strewn through the strata of volcanic ash. Returning to Gillenfeld, we had a little something to eat and drink—the Germans never neglect the inner man—and went on past its crater-lakes to Daur, where we dined at Hotel Hommes. On the card of this inn is a sketch-map of the Eifel, and a geological map and minerals are about the house. While waiting for dinner we picked up a lot of augite crystals from the locality near by. After dinner we hired a dray-cart and pushed on to Dreis, arriving there late, to spend the third night. The next morning, after collecting basaltic hornblende east of the town, in crystals up to the size of an egg, mostly rounded a little by fusion, and taking also some of the olivine bombs, of which so many are scattered through the museums, we went rather across country to Gerolstein. There is much of interest on the way, first petrographic, afterward more paleontologic.

From Gerolstein various further excursions can be made. A visit to the ice-cave of Roth is refreshing in the heat of summer. But the summer tourist must not tarry. So on to Treves, and down the Moselle and up the Rhine, till passing through the ridge of Taunus we emerge into the upper plain of the Rhine at Bingen. From Bingen a side excursion to Münster-am-Stein, if no farther, is of great interest and beauty (17), and those who are attracted by the silver sheen of tiger-eye, the peacock hues of labradorite, or the delicate tracery of moss-agate, should not give Oberstein the go-by. Here, and near by, the semi-precious stones are polished for all Europe, and from Heinrich J. Steffen can be obtained specimens of the melaphyres in whose cavities agates are wont to come, and of the fossils of the region—trilobites and ophiuroids. The view from the station of town and river, and above two castles and a church curiously let into the rock, is said to be one of the three finest on the Rhenish railways.

Near Kreuznach I may mention Hackenheim churchyard and a little southeast as a place where fossils of the Mayence basin abound, and the valley from Kreuznach to Winterburg and back over the Welschberg, with its patch of Tertiary to Bockelheim, as giving a good section of the country. If you want to see more of the Mayence basin, a good way will be to seek the tall chimneys of the cement-factories and the neighboring limestone and clay-pits—e. g., those of Wiesenau. From this region immense quantities of cement are exported to America. The two sides of the great Rhine Valley, which has till recently been considered a typical case of dropping in, are not unlike. Most people go down the east side, and we will follow them. The Taunus region has some interesting porphyroids and sericite

rocks. Next comes the Odenwald. The northern part of this has not been recently described (18) as a whole, although there is much of petrographic interest. The Rothliegendes, with its amygdaloids, is broken through by basalt, which at the Rossberg has glass inclosures, at the Oetzberg sandstone inclosures. In Darmstadt is a museum, which may be of assistance. South of Darmstadt, around Castle Frankenstein, is a mass of gabbro and diorite with many interesting varieties. Near Auerbach marble occurs, and in sundry other places garnet rocks.

We now are approaching Heidelberg, a town well placed as a center for geologic excursions. Benecke and Cohen (19) have, however, one fault as guides. They are too complete; so that a few remarks may not be out of place. North of Heidelberg the petrographer will find much and the paleontologist nothing, for the well-known Triassic sandstone and the Rothliegendes are not fossiliferous. South of Heidelberg, however, past the cadmium and zinc mines of Wiesloch, we can get a continuous section through the whole Trias well up into the Jura. Lime-pits and cement-works quarries afford exposures into the weaker beds, and the workmen have learned to save the ammonites, etc. East of Heidelberg, following up the beautiful valley of the Neckar, we come to the nephelinite of the Katzenbuckel, a stone in places so coarse as to yield when weathered distinct crystals of nepheline.

In the Friedrichsbau of the old university is an interesting collection of maps, models, and specimens. There is also a school of petrography much frequented by students of all nations, especially Americans. On the steep way up to the castle from the Prinz Carl Hotel is the natural curiosity store of Blatz, the oldest house in Germany, I believe, with very reasonable prices. The granite on which the castle stands is best exposed on the Valerien-Weg, a pretty path just beyond the Carlsthor. Leaving the valley of the Neckar, the hills gradually grow lower and more rounded till near Baden we approach the Black Forest through which the Black Forest Railway winds its bold and tortuous way. Geologically this is essentially like the Odenwald, and Eck's inexpensive maps (20) will serve as guides. I should not pass Strasburg and Freiburg without mention. The one, with a university, fine collections, and a geological survey, is the natural center for excursions in Alsace—not so pleasant just now, for geology has less regard for frontiers than have the French and Germans. The other has also university collections, and may be made the center for excursions in the Black Forest or to the Kaiserstuhl, an isolated volcanic peak rising out of the Rhine, and a locality for limburgite, perowskite, and zeolitic minerals. It is mostly cultivated in those oblong patches characteristic of peasant proprietorship.

Switzerland is now our goal, but when should I leave off if I began describing? There the guide-book must perforce pay attention to the works of God that tower so stupendously above those of man. There is even an old scientific guide to Switzerland (31). But while leaving you mainly to the books (2, 3, 6, 10, 12, 21, 22, 31), I may properly emphasize the enormous folding that the rocks have suffered, till gneiss and limestone are intercalated (10), the gradual rise of the chain on the north, and relatively sudden drop-off facing the great plain of Lombardy. The land-slips around the lake of Zug have attracted recent attention, and the origin of the Swiss lakes has already been referred to. The main scientific centers and collections are at Zurich, Berne (where the great smoky quartz crystals are), and Geneva.

Let us still keep south. In the Odenwald, Black Forest, and Taunus, we had seen the old age of mountains, their teeth worn down to stumps; in the Alps we have seen their manhood, the sharp "dents" piercing the sky. In the Apennines we shall find them in youth just cutting their teeth, with gums still bleeding lava. But as you reach Turin, climb over the huge mass of Miocene gravel to the Superga, and cast one long look back. Fear not, for yonder snowy breaker towering high in the north has towered there for generations, and the plain of Lombardy still smiles as green as ever. Finally, we turn our backs to the glorious vision and press on through hills growing ever steeper, sharper, through rocks more and more crystalline, till suddenly the bay of Genoa bursts on our view. At Genoa the university is housed in a grand old palace, but the collections are huddled together. The civic museum is better. A couple of miles west of Genoa, north of Sestri Ponente, are some gabbros and serpentines over which is still a lively discussion. All along the coast of the Riviera we are among rocks that are not old but much disturbed, and contain numerous injections of cupriferous serpentine.

Past Carrara we go—a side-trip expensive and not very rewarding; the snow-white quarries can be seen from the train—and on to Pisa. The collection of the university here boasts the finest cinnabar crystal in the world. It comes from Elba. This interesting island (24*) and Corsica are conveniently reached from Leghorn. A little farther down the coast branches off the line to Saline. This is a pleasant side-trip to one acquainted with Italian. North of Saline is Monte Catini, with copper-mines and a unique mica trachyte—used for mile-posts, and by the Etruscans for carving. Over the gate of Volterra near by is a head of unknown antiquity. Volterra is the center of the alabaster industry, and a gypsum formation crops out frequently

in the neighborhood. Not far off to the south are the borax springs that supply Europe, the nearest being at Monte Arboli. Returning to the main line a little farther south is San Vincenzo, where a cordierite trachyte occurs, and in the works for lead and zinc near by toward Campiglia fine specimens of botryoidal bustamite are to be found.

Soon another line goes off to our left to Monte Amiata, an extinct volcano, whose lava contains interesting glass balls. It has recently been thoroughly described by an American, J. F. Williams ("Neues Jahrbuch," 1887). Half-way from here to Rome the volcanic tufa of the Campagna (25) comes in, and soon we are in sight of St. Peter's. There are collections in the university, but more modern ones at the rooms of the "Comitato Geologico," not very far from the railway-station in the modern quarter. On the Campagna the Roman cement—pozzuolana—diggings should be noticed, and we should go far enough on the Appian Way to visit the quarries in the melilith basalt of the Capo di Bove, whose cavities abound in tiny crystals of melilith, apatite, nepheline, etc. Monte Mario is well known for Pliocene fossils, and from Tivoli comes the famous travertine building-stone of Rome. The region of the Alban Lake affords pretty excursions. The workmen have leucite crystals.

Lago Bolsena is interesting but hard to get at. So on to Naples, where an Englishman, Dr. Lavis, is the present authority (23) on Vesuvius and Monte Somma, and has a fine collection. We should not fail to notice that east of Naples is another volcanic district, in type, time, and products of eruption quite distinct from Vesuvius, the Phlegræan fields, the front garden of the infernal regions, according to Virgil.

Armed with a permit from the palace at Naples, we visit the beautiful park crater of Astroni. The way leads past the famous Grotto del Cane, along the Lago d'Agnano, once a lake, now drained. On the road to Pozzuoli, where the Serapeum has had literally so many ups and downs, is the Solfatara, another smaller but livelier crater. A steam-tramway also connects Pozzuoli and Naples, and this may be made the starting-point of a second excursion among further craters, Lake Avernus, etc., which should certainly include a climb up Monte Nuovo, newest of mountains. May you be more fortunate than I, and have a chance to go farther and visit Etna and Sicily! But most of us must now return. Before we leave, one last warning: don't lay out too much for a day's work near Naples. Water is scarce and bad, wine is not good for walkers, and the climate is relaxing.

On the way back from Rome we will follow the central trough of the Arno and Tiber, which, near the water-shed where the water was dubious which way to go, was for a long time very

marshy, but has been in this century greatly improved by a process of controlling the mountain-streams and making them deposit their detritus so as to increase the grade. Notice on the west side how the layer of tufa overlying Pliocene sands resists erosion and makes flat-capped, naturally-walled hills. The site of Orvieto is a good example. In Florence are also collections, but the Tuscan Exposition of 1887 will probably have altered their arrangement.

At Prato, a little north of Florence, famous for vanilla-drops and a bronze screen, we may leave the train and walk a few miles to Monte Ferrato, where there are quarries of a beautiful gabbro, pietra verde, much used for decoration. It is surrounded by serpentine and porcelanized slate. At the Cave del Acqua it is most coarse and fresh. Soon after we turn sharply and cross the Apennines over to Bologna (3, 23). As from Turin to Genoa, so here—the whole range is Tertiary and the same horizons which in Belgium we saw hardly disturbed since their deposition, are here highly metamorphosed. The University of Bologna has a fine, well-ordered collection, especially to be visited by those who will tarry a little in the Euganeans, where Petrarch was born (10). Thus they will get an idea of the peculiar volcanic products awaiting them. There are still hot baths at Battaglia.

Every one will notice the Holland-like character of the country about Ferrara, and the way the Po flows along with its bed above the adjacent fields, over pebbles from the Alps far away, and will wonder how long it will be before the lagoons about Venice will in their turn become fertile plains. We have been around Italy. We may now go *via* Verona—don't pay the awful prices the man at the amphitheatre asks for his fossils—and Trent up into the Tyrol. The Tyrol and Switzerland are geographically but not geologically divided, so I need add only a reference to the work of Von Buch on the dolomites (10), and that of the Austrian geologists (12*). In Innsbruck is a very full geognostic collection.

We may go hence to Munich, where Groth's new laboratory affords every luxury to the mineralogist and petrographer, and Zittel conducts the most famous school of paleontology in the world, and Gumbel directs the Bavarian survey (3). Or the route to Vienna, by way of the Salzkammergut, is interesting, and the city is a focus of scientific interest, with a magnificent university.

Farther east the casual tourist will scarcely go, although no country of Europe surpasses Hungary in geological interest, where there are several important mining centers. I have been as far as Constantinople, with no extra trouble except that

caused by the numerous dialects. The Austrian geologists are fully abreast with the times.

But, turning from Vienna northwest, we come into Bohemia, the scene of Barrande's great labors. Its mineral springs (28), of which Carlsbad, whence the twinned orthoclase, is the most famous, and Marienbad the best tasting; its coal-basin, its phonolites (that of Neuhof shows the nepheline to the naked eye), and basalts and porphyries, are all noteworthy (35). The rocks near Marienbad have been recently described by H. B. Patton. In this region, too, is a place that should stir the soul of every American, Joachimsthal, the birthplace of the dollar, i. e., thaler. The silver-mines are still carried on in a picayune sort of way, largely for fancy ores, uranium, etc.; but by their gradual exhaustion the population is being driven into the manufacture of Bohemian lace and kid gloves. Bohemian garnets are too well known to need mention.

Passing north, we will follow the valley of the Elbe, which has cut its way through the massive Quader sandstone, leaving it in plateaus or isolated towers, affording the finest specimen of cañon scenery known to me in Europe. The way is lined with quarries, for the cream-colored sandstone is extensively used for building in Dresden and elsewhere, and takes the place of the Bunt or new red sandstone in the region of the Rhine. Not far from Dresden, in Plauen, are large quarries in the rock that is the German type of syenite, and is supposed to have no quartz.

Thence we may go on to Leipsic, the seat of the famous university and of the Saxon survey (3 and 29). Zirkel and Credner are located here. The black pyroxenic quartz porphyry of Kleinsteinberg, close by, has attracted much attention. We are now on the edge of the great plain of North Germany, with nothing but sands washed by glacial drift from Scandinavia to the north of us, except where the Harz (the kingdom of Prof. Lossen) rises like an island (30*). On the way is Stassfurt, whose mines are a chemical storehouse for the world.

There are, of course, other points of great interest in Germany—Freiberg, in Saxony, the star of whose mining-school has passed the zenith. Those who make a pilgrimage to Baireuth are among fossiliferous beds (Allersdorff), and not far from the Fichtelgebirge. The Solenhofen lithographic stone and its fossils are unique, but geologic attention has not been recently concentrated on Würtemberg (26 and 27). We have not yet visited Norway, Russia, Spain, or France. Through the latter country Meunier will guide us (31*, 32, 6). In Paris we must part company, after, I hope, a pleasant tour. Don't fail to visit the Sorbonne and the Jardin des Plantes. All the lectures are public, and the Jardin des Plantes has also fine general collections.

BOOKS AND MAPS SERVICEABLE.

General Topographic Maps.—Baedeker's guides are best in this respect, for Rhine and Alps sufficient. Every nation has military maps covering more or less of Europe. The Austrian map covers most of Europe, and is good.

(1) See the Preis-Verzeichniss of R. Lechner in Vienna (Wien). Also—

(2) Stanford's Tourist Catalogue, 1884, with addenda and corrigenda since (gratis). This firm's specialty is geologic and geographic publications. The guide to the Isle of Wight by M. W. Norman, 1887, may not be catalogued yet.

(3) For geologic maps see National Geological Surveys of Europe, by William Topley (6*d.*), 1885, London, Trübner & Co.

Note that the official surveys are not always strictly confined within boundary-lines. So the Austrians have done much work in the Balkans, and the earlier French survey of De Beaumont covers one's route up to Italy or the Tyrol. Many of the books and geologic guides mentioned below include or accompany maps. Such are starred. Of bulky works on European geology the following are the best:

(4*) Ramsay, Physical Geology and Geography of Great Britain (11*s.* 6*d.*), 1878, E. Stanford, London. Just out is Woodward's Geology of England and Wales, 1887, 18*s.*

(5*) Geikie, A., Text-Book of Geology, 1882.

(6) De Lapparent, Traité de Géologie, 1885, F. Savy, Paris. (The last seven hundred pages contain a full account of the formations in various countries, with references.)

(7) Mourlon, Géologie de la Belgique, 1881, F. Savy, Paris. (Purely local.)

(8) Credner, H., Elemente der Geologie, 1883, Leipsic, Engelmann.

(9) Roth, J., Allgemeine und chemische Geologie, 1879–1883, W. Herz, Berlin. (The second volume, just complete, is full of petrographic localities and references.)

(10) M. Neumayr, Erdgeschichte (16 marks), 1886, Bibliog. Institut, Leipsic. Very fresh and finely illustrated.

(11) Suess, Das Antlitz der Erde.

(12*) Von Hauer, F., Geologie (as applied to Austria), 1878, A. Hölder, Vienna (Wien).

Of smaller transportable works may be mentioned the following:

(13*) Geikie, Outlines of the Geology of the British Isles (2*s.*), 1876, W. & A. K. Johnston, Edinburgh.

(14) Geology of Belgium and the French Ardennes (1*s.* 6*d.*), 1885, Stanford, London. (By various writers; includes rough sketch-map and references to Dewalque's map, etc.).

A joint excursion in the environs of Brussels was made by the Geologic and Malacologic Societies, reported by A. Rutot, 1881. A separate reprint of this would be the best guide. Such reprints are valuable guides, and are often advertised in catalogues of second-hand books, or may also often be obtained of the secretaries of the various societies or the authors.

(15*) The agricultural geology of Belgium, sketched in 14, is treated more fully by Malaise and De Laveleye.

(16*) On the geology of the Rhine (Baedeker has something), Von Dechen has a series of Geognostische Führer in das Siebengebirge, Vorder-Eifel, Hinter-Eifel, etc. In society proceedings, various papers by Wolff, Hubbard, Laspeyres, etc.

(17) Führer für Besucher des Nahethal, 1884, Voigtländer, Kreuznach, has geologic and botanic appendices.

The work of the Prussian Survey of Weiss and Laspeyres, and the Flötzkarte of Saarbrücken may be noticed.

(18*) Ludwig, R., published a Geologische Skizze, to go with the map of Hesse (see 3), out of print now. There is a new survey by Lepsius in course of publication.

(19*) Geognostische Beschreibung der Umgebung von Heidelberg, Benecke & Cohen, 1877.

(20*) Eck, H., has issued a series of good maps on the Black Forest, the Black Forest Railway and environs, Renchbäder, Ottenhofer, etc., very much detailed, poorly printed, and cheap in price; 1885–'87, Lahr.

(21) Heim, A., is the great authority on the structure of the Alps, folds, faults, etc. His results are given, however, in (6), (8), and especially (10). Tyndall and Agassiz are mentioned, *honoris causâ*, on glaciers.

(22*) Stapf, Geological Map of the Saint Gothard Railroad from Erstfeld to Arbedo, 1:25,000. Practically covers the whole crystalline belt.

(23) Italy has been traversed by so many that the geological literature is wide-strewn. A bibliography was published in 1881 for the International Geological Congress at Bologna. J. Roth's Vesuv. and Lavis, in the "Quarterly Journal of the Geological Society," London, are up to date.

(24*) Lotti, B., Desc. Geol. del Isola Elba, 1886.

(25) Carta Geol. della Campagna Romana, 1880, Roma.

For the Tyrol the Italian part of the Austrian publications should be noted. Guides to collections often have a wider usefulness. Among such pre-eminent are those for Berlin and Strasburg.

(26*) For Würtemberg, besides the old Geognostische Verhältnisse, by Hehl (1 mark), 1850, Schweizerbart, Stuttgart, is the newer—

(27) Die geognostische Sammlungen Würtembergs, by Oscar Fraas (0·50 mark), third edition just out, Schweizerbart. Stuttgart.

(28) Laube, G., Geologische Excurs. im Thermalgebirte des N.W. Böhmens, 1884, Leipsic. Among other workers in the same field in journals are Reuss, Boricky, Becke, and Patton.

(29*) Credner, H., Geologischer Führer durch das sächsische Granulitgebirge, 1880, W. Engelmann, Leipsic. There is also a fuller "Beschreibung" by the same author.

(30*) Lossen, K. A., has published a very thorough map of the Harz, which is expensive. The literature is mostly published by the Prussian Survey. See (3), as also for Bavaria.

(31) Meunier, S., Excursions géologiques à travers la France, 1882, G. Masson, Paris. (Chatty; includes Belgium and part of Switzerland.)

The smaller French school-books, e. g.—

(32*) Von Raulin, Éléments de Géologie, are very local, and handy to the pocket.

(33) Catalogues to porcelain manufacture, to geologic models, to rock specimens, fossils, mineral collections, mining records, and guide to geology of London (prices 3*s.*, 2*s.* 6*d.*, 2*s.*, 2*s.*, 4*s.* 6*d.*, and 1*s.*), Museum of Practical Geology, Jermyn Street.

(34) Scientific Guide to Switzerland, Morrell. I have not tested it by experience.

(35) Hibsch gives the literature of northwestern Bohemia in Tschermak's Min. and petr., Mittheilungen, 1887, Wien, Alfred Holden.

EDUCATION AND THE EMPLOYMENT OF CHILDREN.

By ELIZA F. ANDREWS.

FOR years the world has been on a moral crusade against the employment of children in mines and factories, while the far greater evils that result from the mothers going out as wage-earners have attracted comparatively little attention. Labor, within certain limits, is good for the child, giving it a wholesome moral discipline, and training it for the business by which it is to earn its livelihood; but, when a married woman has to neglect her natural duties for the responsibilities that properly belong to the other sex, it is time for humanity to protest in the name of her offspring. No one individual can fulfill satisfactorily the double or, I should say, the triple function of bearing and rearing children, and providing for their maintenance. I am a laboring woman myself, and have met with some success as a bread-winner; and I know that the conditions of performing this function satisfactorily are quite incompatible with those arduous and important duties which make such heavy demands upon every conscientious mother, especially among the poor. In the homes of the very poor there are no hired servants to keep the household machinery running smoothly while the mistress is away. The wife of the laboring man is frequently cook, nurse, house-maid, laundress, all in one; and if she must go out as a bread-winner besides, what is to prevent the domestic engine from running off the track and getting itself hopelessly ditched?

Of the two evils, if both are evils, I am persuaded that it is better that the child should go out to labor than the mother. Liberty, uncurbed by the check-rein of parental restraint, is a more than doubtful blessing, for the loss of which the child that takes its mother's place in the shop or the mill is more than compensated by the advantage of having her care at home. It is of far greater importance to the physical and moral well-being of the child that it should have a clean, well-ordered home to receive it out of working-hours, than that its working-hours should be abolished. The real hardship to the children of the poor lies not in setting them early to learn the wholesome lesson of labor, but in leaving them to grow up amid the discomforts and dangers of a neglected home, while the mother is bestowing upon loom and spindle the care that is the natural birthright of her little ones.

But here we are confronted with the question of education, and it will be asked, How is the child ever to learn anything if put to work so early? Such considerations, however, need present

no real difficulty, if we could once rid ourselves of those narrow views of education which bound it by the walls of the school-room, and can see no way of learning anything except by getting it out of a book. Education, in the proper sense of the word, is that course of training which will best fit an individual for the business of life, or, to speak more accurately, will best enable him to adjust himself in harmony with his environment. The kind of education that is best for any person will depend, therefore, very much upon what his environment is to be; and as it certainly can not be maintained that the environment of the majority of mankind is such as to require a very great amount of book-learning, it may reasonably be asked whether some of our popular theories of education do not need remodeling. By this I do not mean that our facilities for higher education should be in any way diminished, but only that we should use a little more discrimination in applying them, and bestow the highest advantages where they are likely to do most good. Many well-meaning teachers labor under the idea that they must spend their best energies upon dull pupils, and go on for years throwing away their time in trying to accomplish what the homely wisdom of our fathers has pronounced the impossible task of making a "silk purse out of a sow's ear." Trim your sow's ear, clean it and comb it and make as decent and reputable a sow's ear out of it as you can, by all means, but don't put your gold and pearls into it, under the belief that it is a silk purse. As our Georgia farmers say, put your guano on your best land, and you will get a paying crop.

Each department of the world's work can be best carried on by those who are fitted for it. The intellectual work, like every other, can be carried on with success only by those who have some capacity for it, and, by bestowing an elaborate intellectual training upon all alike, without regard to natural qualifications, we damage both the state and the individual: the state, by wasting its resources in unremunerative intellectual products; the individual, by leading him into fields where he is forced into competition with those better equipped for the struggle for existence, and against whom, by the inexorable law of the "survival of the fittest," he has no chance to contend with success.

Where people have money to pay for the education of their children, there is, of course, no remedy; and in our private schools and colleges we may expect always to see rich blockheads grinding through the process of what they call getting an education; but where the state pays the cost it has a right to see that its money is spent so as to secure the greatest benefit to all concerned. This can be done by a rigid system of grading, each school being a stepping-stone to the next higher. Let a

certain standard of scholarship be required in each grade as a condition of entering the next higher, and let all who do not come up to this standard pass out to the factory, the workshop, the plow, the wheel, the lathe—to whatever, in fact, is to be their life's work. The requirements in the lower grades should not be too high, and every one should have an opportunity of learning to spell, read, and write, with something of the four cardinal rules of arithmetic; but after that the standard should be rapidly raised, so as to weed out all but the best material before reaching the high-school, and thus avoid the great economic mistake of turning into poor scholars material that might have made good artisans and mechanics.

Under such a system, the weary mass of juvenile mediocrity that cumbers our high-schools and keeps down their standard of scholarship would be switched off early on the right track; for, since the vast majority of the human race must live by the work of their hands, it is quite as important that the hands should be educated as the head. Schools of technology are needed for such of this class as may be destined to callings requiring special skill, such as architecture, joinery, engraving, and the like; but, for the rank and file of hand-workers, I question whether the mill and the workshop are not the best schools. To many they are the only available ones, for the families of the very poor can ill afford to sustain non-producers, and to them it is essential that the labor of every member should be directly remunerative.

If we take this broader view of education, there is no reason why its claims should conflict with the humane employment of children in work suited to their strength, at a comparatively early age, and there are cases where the enactment of laws against it would be a positive cruelty to the children themselves. Especially is this true where keeping them at home would necessitate the mother's going out to labor. Unmarried females can work as bread-winners without detriment to themselves or to society; and the ever-increasing band of "superfluous" women, which is so significant a feature of our advancing civilization, is quite sufficient to supply all demands for female labor without calling mothers away from their natural post of duty.

It is not a matter of mere sentiment to reserve the mother's time and labor for her children, but of sound political economy. There is no question of greater importance to the state than the training of its future citizens; and a home where thrift, cleanliness, and good government prevail, with that moderate amount of domestic comfort which the hand of a tidy woman can impart to even the most meager surroundings, is a more powerful factor in the production of a good education than all the schools in Christendom. I have often been struck, in the school-room, with

the vast difference that exists between well-mothered children and those poor little Ishmaelites who, through want of either time or capacity on the part of the mother, are left to scramble along the path of life as best they may. The teachers, with all our books and methods, can not lead a child even to speak correctly, when it hears nothing but bad English at home; how, then, can our endeavors, temporary and intermittent as they must be, counteract the demoralizing influence of the shiftlessness and disorder that prevail in a home from which the mother is always absent? It is beside the mark to object that the mothers themselves are often so ignorant and thriftless as to make their presence little to be desired in any home; can we expect to find models of the domestic virtues among those who have never had the opportunity to practice them? We all know that there are foolish and incompetent mothers in every walk of life; but would any one, therefore, argue that it is good for children in general to be deprived of the care of their mothers? Such faults of the poor as arise from lack of opportunity we may hope to correct; those that are inherent in human nature I leave to the moralist, as beyond the scope of this paper.

THE ISLAND OF NIAS AND ITS PEOPLE.

By H. SUNDERMANN, Missionary.

THE island of Nias is situated in the first degree of north latitude, and between the ninety-seventh and ninety-eighth degrees of east longitude, and is the largest of the chain of islands that stretch along the west coast of Sumatra. It is about seventy miles from Sumatra, and is about seventy-five miles long and from eighteen to twenty-five wide. It consists almost entirely of hill-land, through which road-making is difficult, and this, with the thick, tall grass rendering the narrow native paths invisible except almost at the traveler's very feet, makes communication difficult. Animal and vegetable life are sparsely represented. There are no dangerous animals except crocodiles and wild swine, which last are very destructive to the cultivated fields. The only domestic animals are swine, hunting-dogs, cats, hens, and a few goats. The timber-trees, in considerable variety, furnish good building-woods; the cocoa and durian are the principal foods. Sago and sugar palms, rice, yams, caladima, pisang, a sort of spinach, and a small bean, are the principal cultivated plants.

The people call themselves "Niha," which signifies "men," and their island "Taño Niha," the land of men. No definite ac-

counts exist of their origin. Some say that their ancestors came down from the sky. Another account traces their descent from the daughter of a Batta chief of Sumatra, who, having been expelled from her home for unchastity, was set adrift in a canoe, landed in Nias, and had children by a son who was born to her there. They themselves believe that they are descended from several ancestors who settled at different places on the island, and originated the various tribes into which the people are divided. They may be supposed to number about three hundred thousand. They are of medium stature, are easily tired out, and are not unlike the Malays in physiognomy. Their costume is primitive, and consists, for the men, of a strip of cloth wound around the loins and between the thighs, and so girt as to leave the ends hanging low down in front; for the women, of a square cloth, ornamented on the lower border, wrapped around the hips so as to constitute a short petticoat open at one side. In addition, the men sometimes wear a kerchief, jacket, and belt of cloth or leather, and, on festive occasions, a *sarong* thrown over their shoulders. The women, when they would be more fully dressed, wear a jacket and a *slendang*, or long cloth thrown over the shoulders, and carry a brass-mounted staff with a leaden head; while their hair is done up with brass, silver, or golden pins, and encircled with a brass or pearl-embroidered fillet. The most conspicuous of the golden ornaments is the crown, a conical framework structure fitted to the head, and adorned with golden leaves stamped with a human face, miniature palm-trees, and other curious decorations. The weapons consist of a lance, a knife or sword, and a shield; armor of overlying thick jackets or coats of buffalo-hide, and helmets woven out of palm-leaf or cocoanut fibers. A few possess old rusty guns or small cannon for festive occasions, but the introduction of fire-arms is forbidden by the Dutch Government. Their beds are mats, their pillows blocks; and for dishes they have porcelain-ware or pisang-leaves, which do not have to be washed. The housekeeping outfit also includes pork-trays, scales for weighing pork, and a smaller balance for gold, a cupboard made of hollowed logs, the rice-stamping apparatus, earthen cooking-pots and wooden troughs, and, for tools, knives, a primitive hatchet, a chisel, a file for the teeth, and a smith's stand. The houses stand about six feet above the ground, on posts which are set upon stones, a style of building which prevails without respect to situation; for it serves a good turn for defensive purposes, and affords room for the pig-pens beneath. The shape is oval, and the palm-thatched roof is very steep, and ridged instead of pointed. The entrance opens into the principal apartment, which occupies a middle position, with rooms at either end; and all the rooms

contain fireplaces—boxes filled with earth—and secret exits for escape in case of attack.

The language is difficult, but I have not found it poor in conceptions, and have met no formidable difficulties in translating the Gospels into it. It has no literature, and has only recently been written. Myths, parables, proverbs, riddles, the wisdom of ancestors, and the recitations at the dances, are all transmitted orally, and are thereby current in many versions.

The people are of childlike simplicity, careless, often sportive, dreadfully given to falsehood, and unconquerably averse to saving or making any provision for the future. Not even the desire of getting a wife, who has to be paid for, will induce a young man to save; he would rather borrow of a chief, and so put himself under obligations which are almost sure to be equivalent to servitude. The chief occupation of the Niha appears to be idling away the time. What little work is done with any regularity is chiefly performed by the women, who have to take care of the swine and look after the food.

While the special time for contracting loans is a month after the harvest, borrowing goes on all the year round. If the debtor can not pay at the maturity of his loan, the creditor acquires the right of making himself at home in his house, and demanding and receiving the best until he is paid. A similar privilege is accorded to guests, who are entertained with great show of hospitality, and are very apt to make the most of it, in complete indifference to the comfort and feelings of the family.

While the island is nominally under the rule of the Dutch, it is in fact under the control of a set of Liliputian chiefs, who are quite independent of one another, but have the most exalted idea of their magnificent importance. Their title, *baleozoe*, which may also be acquired by any one who gives a grand feast, is often adorned by some supplementary epithet, like "the foundation of the earth," "higher than the comb" (of a cock), "who is nothing else than fire," "who is always above," or "who is higher than the Malays." No real connection exists between the different clans. Head-hunting is very much in vogue in the interior; but in the northern part of the island an occasional bleached skull, suspended from a post, is the only reminder that it once existed. Severed heads, where the custom still prevails, must be had on a variety of occasions, as on the burial of a chief or the foundation of a house. One of the peaceful tribes whom I visited in company with Controller Mansveld, in January, 1877, complained of the losses they had suffered from a more warlike neighboring tribe. One local chief had lost twelve of his people in six months, another eleven, and another ten, including women and children; and another exclaimed that the tribe was in danger of

being exterminated. The murderers are hired, and put their own heads or those of their children in pledge when they go out on their expeditions, to be forfeited in case they bring in no strange head. The food of the departing head-hunter is set in the pig-trough, as if to say that he is no better than swine or a dog if he comes back empty. If they return, bringing one or more heads, they are feasted in grand style; but if they have nothing, themselves or their children are slain.

The village chieflets nominally stand in a kind of patriarchal relation to their people, for they are all more or less directly or distantly related to one another. Hence they are usually spoken of as father by the older people, and grandfather by the younger. But the chief function of this patriarchal relation appears to be the exaction of exorbitant interest and hard terms for loans. The thoughts of the chiefs are turned to the accumulation of gold ornaments and to making a great name for themselves. With an eye to the latter object, they plant large stones in front of their houses—male stones, long and slim and set upright, and female stones, broad and flat, and laid at the feet of the former, either being sometimes hewn to the shape of the human figure. The institution of the stones, or the acquisition of a valuable ornament, is celebrated by a great feast, at which hecatombs of swine are slaughtered, the people, especially married persons, being expected to contribute portions of the pork. Every chief who desires to be of consequence must give such a feast once at least in his life; and then he gets a new name, corresponding with the additional luster with which he imagines his fame has been invested.

Women are in low estate, under the pressure of a kind of polygamy. Mourning for the loss of a wife is eclipsed by lamentations for the money she has cost the widowed husband. To the husband, the wife is "the one who does his work," or "who takes care of his food." If she does not suit him, instead of getting a divorce he takes another wife and makes the former one a slave, with a regret that he had paid so high a price for her. If the husband dies, his brother or father takes his wife; for it would be a pity to let the value she represents go out of the family, and a widow will not bring more than half as much in the outside matrimonial market as a young girl. The son takes the wife left by his father, provided she is not his own mother. Children grow up like the grass and weeds, without discipline. Parents love them too much to punish them, and limit their training to empty scoldings. The family feeling is very strong, and is hardly lessened after the members have grown up to maturity and married. Assaults upon women, even of the most trifling and indifferent character, are punished by fines. Illegiti-

mate children are put into a sack, with an egg and a stick of sugar-cane, and hung on a limb to starve. Murders are avenged in blood by the friends of the victim, or the crime is brought before the chief and punished with a fine, of which the relatives receive a part. In case this is not acceptable to them, they proceed to exercise justice according to their own views.

Thefts are punished by death or fine. If the thief is not found, a curse is issued against him, by, for instance, burning a dog alive and invoking a similar fate upon the guilty man. Ordeals are employed for the detection of thefts—as the ordeal of water; or a hen's head is cut off, and notice is taken of the person toward whom the decapitated fowl flies. The resumption of friendly relations after disagreement is sealed by the imprecation of a terrible curse upon the party who shall renew the quarrel. The parties and their friends in succession take in hand a palm-leaf which is supposed to represent the person upon whom the curse is destined to fall, present it before the ancestral figures, and say, "If any malice is left in N. N.'s heart, if he seeks to do harm to the other, then twist his neck, O image of my father, image of my grandfather!"

When a child is born, the father and mother must refrain from doing anything that can possibly suggest evil, lest it fall upon the child. They must not slay any beast, they must not eat of a pig that has died (to which otherwise they are not averse), they must not pass by where a man or an animal has been killed, or make an idol or a water-trough, or blow a bellows, or burn a field, or heat iron, or take a knife in hand, etc. In any such cases, the child is supposed to acquire some of the unpleasant qualities associated with the obnoxious object or act, in a symbolical if not real sense.

In time the child is introduced to the ancestral gods, and a name is given him, which usually has some particular significance, and often relates to some fact in the family history. Daughters are not welcome, and are liable to be given such names as "The no use," or "It doesn't taste well." But many of the unpleasant names that are heard are such as are given as nicknames "for luck"; for, when a child is called by his true name, the evil spirits may learn it and bring harm to him. Circumcision is customary, in connection with which offerings are made for the child's health, and to inform the ancestral gods that the rite has been performed.

The price of brides varies according to their station, and is shared by the girl's relatives, the chief, and the people of the village; but the village people's share gets divided into too small sums to be reckoned in money, and is paid out in little

dried fish, or in salt. Betrothals may take place at a very early age—sometimes before the girl is born, or even when there is no present prospect of a girl.

The bride-seeker, starting on his quest, pays great attention to his dreams. If they are of fire or flood, the matter has a dubious aspect, and he usually gives it up; but to dream of clear water or of receiving money is a good sign. The girl is not consulted, and all is arranged by intermediaries, without the parties seeing one another. A few days previous to the wedding the bride goes round and takes leave of her relatives, with lamentations that she is to be consigned to strangers—for marriages are always between persons of different clans—and receives their wedding-gifts. Then, just in time to be at the wedding, the people of the groom's village march to the bride's village with drum and song, and parade the streets, brandishing their drawn knives and shouting, till a wild dance is started, which passes into a long, serpentine movement with windings and inwindings, and the chanting of a recitative by one of the participants, and the repetition in chorus of the last strophe, or its final sound, which is always a vowel. There is nothing like singing in this, for musical song is not known in Nias. The women dance in pairs, deliberately and gracefully waving the ends of the scarfs which are hung upon their necks. A breakfast follows, and a more elaborate dinner in the evening.

The bride sits through these proceedings with downcast eyes, wearing an air of modest reserve. Previous to her leaving the house, she must be paid for; and then she will not go, and has to be taken out. When she has been successfully brought down the ladder, the groom is called and saunters out from the throng like one of the most indifferent persons in it. Then the heads of the pair are made to touch at the foot of an idol-post which has been planted in front of the house, usually against the resistance of the bride, and they are a married couple. The groom rubs the bride's lips with a certain leaf, telling her she must not be obstinate, and she is led away—for she will not go of herself—between two women.

On arriving at the groom's residence, a kerchief is thrown over the heads of the couple, and the chief gives them his blessing by waving his sword over them. The bride is taken into the house without her taking hold of the ladder—for the rafters are the first thing to be touched by her—and, when she is seated, a boy is placed upon her lap, in token of her becoming a servant, after which she gives betel to her husband.

The groom or his father gives a feast in his turn, at which a consultation of entrails is held after the old Roman fashion, to determine what the character of the bride's life will be. She

is introduced to the ancestral gods, and is expected to take hold of the palm-leaves with which they are decorated.

The first thought when a person becomes critically ill is to prepare his coffin, a hollowed log closed with a plank. The nearest relatives prepare food for him, and receive his farewell. On the approach of the last moment, the dying man's eldest son lays his mouth against the father's, to receive his spirit, which is believed to come from the mouth in the shape of a pebble. If the man has no son, the spirit is received in the money-purse. It is afterward hung upon the ancestral image which is prepared to represent the deceased, and is supposed to enter it. When received by the son, it is thought to help make him a wise and valiant man. After death, mourning is begun with the beating of drums and the firing of guns, if powder can be got. The nose of the deceased is closed, his chin is bound, and his great toes and his forefingers and thumbs are tied together, to facilitate the escape of the immortal part. A dance, not unlike the marriage-dance, is accompanied by chants reciting that the deceased is not really dead, but is only gone away, although he will never return from beyond the seas to the present world. The funeral feast is marked by the number of swine that are slaughtered for it, and this appears to be the question that most occupies the minds of the public when a death is announced. While the coffin is being brought down into the throng of relatives, some may be inquiring whether there are any circumstances to indicate murder; others may be holding before the deceased articles that he highly prized, in order to outbid any persons hostile to the family who might try to entice his spirit away from them.

A pot of chicken and rice is pushed into the coffin for the use of the deceased in the other world. The coffin having been laid in the grave, the stem of a certain plant is inserted so as to stick up through the surface of the ground and form a way of exit for the *mŏkŏmŏkŏ* or relic of the heart, which is expected to rise from the grave in the shape of a little spider—this only in case the deceased has left posterity. While the dead are usually buried as soon after death as possible, if the family have not at hand the swine required for a suitable feast the body may be kept in the house, in a tightly-closed coffin, for a year.

Food is set at the foot of the house-thatch twice a day for a few days after the funeral. The idols which the deceased had had made on the occasion of his sickness, and the articles he had used, are placed by the grave, so that the ghost shall not return to the house for them. A wooden image of the deceased is made, and his immortal part is invited by the priest to take its abode in it.

An amusing ceremony is that of the recovery of the *mŏkŏ-*

mŏkŏ, a little spider which is looked for on the grave, and is regarded as the relic of the heart. Sometimes the ceremony is delayed for several years; and if sickness occurs in the family in the mean time, it is considered an infliction on account of the neglect. The grave having been cleared up, rice is scattered over it, and clothing and jewelry are laid upon it. The family then squat around it, stretch out their hands, and invite the mŏkŏ-mŏkŏ to come, and delay not; all the relatives are there waiting for it. A piece of clothing is lifted up, and a spider is discovered under it—they are running all around, for that matter, by the dozen. It is not caught at once, but is invited to come upon the outstretched hand. Now it is discovered that it has six legs, and can not be the mŏkŏmŏkŏ spider, for that should have only four legs; no, it is the right one, after all, for two of the supposed legs are only hairs. When the genuine mŏkŏmŏkŏ is found and identified, it is put into a bamboo cane and brought to the *dela* (bridge), a kind of gathering-place of the dead, where a stone is planted for each deceased person, before which potsherds are set to represent a plate and a flask. A kind of festival is held here, after which the mŏkŏmŏkŏ spider is set free close to the ancestral image, which it is supposed to enter. An egg is offered by each person present, and the family are counted over before the image, and prosperity is invoked for each one, as well as for their herds and fields. If a crack appears in the image, which is of wood, they say that the mŏkŏmŏkŏ has escaped from it, and a new image must be made and instituted with a repetition of the ceremonies.

The religion of the Nihas consists really of the worship of demons and of ancestors, while there are two beings who are neither, to one of whom the highest power is ascribed, and whose name is invoked in oaths; but they are worshiped only in an indefinite sort of a way.

Their psychology is very peculiar. Besides the spirit *sheha*, whose transmission to posterity in noble families has been described, they speak of the breath or soul, *noso*, which has a kind of pre-existence—not in a personal form, but as a part of the general soul-stock, from which each person's portion is weighed out or cut off from a line—each one being asked at birth how much of it he will have. Upon his answer, and his consequent allotment, will depend the length of life that he will enjoy. The immortal part, *bechoe zïmata*—a spirit distinct from the sheha—is regarded as a mere shadow, having a hypothetical continued existence.

A peculiar central position, and a multitude of functions, are ascribed to the heart. It is the seat of thought, understanding, and feeling; and a remnant of it comes out from the grave after

death in the form of a spider, seeking lodgment in the ancestral image, as has been already described.

The Niha conceptions of the condition after death are confused. The *bechoe* go below into the city of the dead, where they have to die nine times, or, according to some, as many times as the man has lived years on the earth, and are supposed to lead lives like the earthly lives. They take with them their earthly utensils and possessions in the form of shadows, and can not expect to attain a higher state of wealth than they did on the earth; therefore living men accumulate as much wealth as possible, in order that they may take the shadow of it with them. The bechoe of wicked men return to the corpse in the grave, and are crushed by the earth. Men who have no male issue are turned after their manifold deaths into night-moths; those who are murdered, into locusts. The bechoe of murdered men and suicides are assigned separate abodes from the other bechoe. At last, it is said, the earth will die, or sink into the sea, and there will be a new earth. Then the bechoe of the cats will let the bechoe of the men go over the gulf into the new earth, the edge of a sword serving as a bridge. Any one who, in life, has causelessly tormented or killed a cat, will be thrown by them into the abyss. Therefore every person is afraid to go near cats to annoy them. Only those also who have had issue can go over, while others become butterflies or something of the kind. The bechoe of children are carried over by their mothers, and go to God.

After Lowalangi, with whom men have little to do except to make an occasional offering, the most important of the divinities is Latoere. He tried to make men from the tora-fruit, and, not succeeding, called upon Lowalangi to help him, and received the creatures as a gift of swine. Hence he is called Latoere of the thousand swine. He occasionally eats a man—that is, his shadow—as one would slaughter and eat a pig, when the fact is manifested by the illness of the victim. In this case an offering is made to induce him to choose another, fatter man, from a different part of the country. If this petition fails, the man will have to die. There are other demons, who feed upon the shadows of men, stalking like hunters through the land, using the rainbow for their net, and assisted by air-dogs, whose heads are turned round so as to look backward, and which are occasionally heard to bark. It is possible, however, by means of special offerings, to make one's self unfailingly sound, unless Lowalangi has decreed that there shall be an end of the person in question. The shadows that fall victims to these divine appetites are special shadows, and not those which are cast in the sun.

The people also imagine underground ghosts, or bechoe, which live in caves or holes, and trouble men or eat their

shadows. The bechoe of women who have died in childbed are supposed to seize men's arms and try to twist them around and set them wrong side foremost. A kind of angelic being is appointed to convey the souls of the dead back to the soul-stock or string from which they were cut off and allotted to their personages at the time of their birth. Next in order are those ancestors who are honored on special occasions, and after them the near ancestors, of whom images are made, which the mŏkŏ-mŏkŏ accepts as its abode. Offerings are made most usually in a propitiatory shape, as when Latoere is asked to choose another man instead of the one he has made ill, or the shadow of a pig or of a hen is offered to the bechoe instead of the shadow of a man.

The priests form a separate class. The sign of the calling to the office is a fit of insanity or some illness. After a spell of wandering, the candidate qualifies himself for his functions by means of a short course of instruction from an active priest.

The minor divinities, or *adoes* (idols), are very numerous; and in order to make sure of accosting the right one for a particular occasion, the priest institutes a kind of ordeal. One of the test-forms is to name the list of the divinities while trying to make an egg rest on a bottle: the one at whose name the egg stands is the right one. A new adoe or idol has to be carved for every case of illness; and the offering is made while the patient is holding the image in his hand, with drumming and prayers. In invocations of Latoere, three mediators are employed between the priest and the god; the adoe, which is asked to transmit the matter; Saho, who was formerly a man on the earth, but has been translated to the sky, who intercedes with the third mediator, a being whose part in the affair is not very clear.

If the prayers find a hearing, Saho reveals the sign, which is manifested in a great wave or cloud floating above, but can be received only by sunlight. The priest intercepts it with a cloth, upon which it is reflected, in a shape like that of a glow-worm, and puts it upon the patient's brow, whereupon he is made well. This sign, called *soemange*, is also received in answer to many other offerings which are not made to Latoere, but it always comes from him, upon whom life or death ultimately depends. Offerings to the ancestral gods are seldom made in cases of illness, but usually to ask a blessing or avert misfortunes, or on special occasions, as the birth of a child or a marriage, in the way of announcement. These divinities are held in very high honor, and all manner of evil is predicted against any one who renounces them and goes over to Christianity.

A sin-offering is made for a chief who in any affair or case of offense has not done right, and is afraid that he will be made

ill on account of it. The adoe of some former (deceased) magistrate is then called upon to turn away the evil; and when any one is cursed, he endeavors to ward off the effect of the imprecation by an offering. Adoes are also made and offered to drive off evil spirits or to warn off the spirits of pestilence that may be approaching the village. The occasions for offering are, in fact, innumerable, and persons who suffer much from illness are made poor on account of them.

The adoes are supposed to have originated from above; and the kinds of wood out of which the idols are made are the children, turned into wood, of the divinities which, according to one version of the legends, sprang from chips of wood, and were sent down to heal the diseases of the earth.

Diseases which are supposed to have been produced by curses and enchantments are also met by offerings; but a certain list of disorders, which are caused by a tree that is supposed to have arisen from the spirit of a curse which was uttered by a certain chief against his townsmen—including fevers, disorders of the stomach, and contagious skin-diseases—have to be treated with medicine. The field of superstition is much better tilled by the Niha people than are their rice-fields.—*Translated for the Popular Science Monthly from the Allgemeine Missions-Zeitschrift.*

ANIMALS AS MODIFIED BY ENVIRONMENT.*

By J. B. STEERE,

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THE close connection between animals and their surroundings is generally recognized both by those believing in creation by design and by those holding to evolution. This connection is usually supposed to be restricted to the adaptation of certain organs to specific facts of surrounding environment. Often-quoted examples of such related organs and conditions are the eye and light, and the ear and sound.

In addition to this undoubted adjustment of single organs to individual conditions of environment, there is reason for believing that each natural division of the great animal types, the most fundamental as well as the most trivial, is adapted in the same sense to its own special fact of environment. In other words, all modifications of type have been in the line of adaptation to special conditions; and, where such modifications are

* Abstract of a paper on "The Importance of Individual Facts of Environment in the Formation of Natural Groups of Animals," read before the American Association for the Advancement of Science, Ann Arbor meeting, 1885.

distinct enough to be recognized by the classifier, the facts of environment on which they depend should be distinct enough to be discovered by the observer of animal habits.

This proposition can be established only by the connection of structure with habits and with conditions of environment in a large number of groups of different values in each of the types. Its reasonableness is best shown by the fact that it is recognized as true in those groups whose habits and structure are best known. The difficulty of establishing it as a general truth lies rather in the lack of knowledge of animal habits and surroundings than in a lack of knowledge of structure.

A few undoubted examples of adaptation of groups to special environment are of birds to aërial habitat, of fishes to water, of rodents to hard foods, and of squirrels to arboreal seeds with hard coverings.

One of the difficulties in tracing this connection between existing groups and the environment to which they are adapted is in this, that the more fundamental structural characteristics may remain after the animal possessing them has, by later superficial modifications, become adapted to other and perhaps antagonistic conditions, and even after the conditions leading to such structures have disappeared. Of the first case we have such examples as the ostrich and penguin, which, while retaining their bird characters, have lost flight, and have become, one of them terrestrial and the other aquatic; and the bats and whales, mammals which are no longer capable of existing in the normal mammalian habitat.

Of examples of the last case, animals existing after the conditions leading to their existence have disappeared, we can not be so sure; but the marsupials and the proboscidians among mammals, and the turtles among reptiles, may be examples in point. If animals may become superficially modified so that they may exist under conditions different from those for which they were primarily fitted, they might still exist after such primary conditions had ceased to exist. Whales might exist if all land were destroyed.

Another difficulty in connecting animal forms with special conditions of environment is in the multitude and variety of modifications that have taken place. No type of animal life has stopped at one set of changes. If there was one species of bird, and that fitted in a general way for all bird-life, one of mammals, one of fishes, etc., the problem would be simple; but as soon as a group of animals has become adapted to a new fact of environment it falls under the influence of a new set of surroundings, more or less numerous, from the very fact of such change, and again becomes broken up into subdivisions adapted to each of

these. This process is repeated again and again until groups of animals are reached in which the differences of structures separating them from others become so minute that they are called varietal or specific, while the differences of environment to which these subdivisions are adapted grow fainter and fainter, until, when the point is reached where the classifier is compelled to throw together a number of animals and call them a species, because he can no longer find structural differences to form divisions upon, there the student of animal habits will find the same animals related to practically identical facts of environment.

An example of such changes in environment and of such following modifications of structures may be taken from the mammals. Primarily arboreal in habits, and climbing, with hands developed on one or both pairs of limbs, their skulls and jaws and teeth were fitted for masticating their food. All of their supposed ancestry had simply swallowed their food whole.

This mammalian character of the teeth, when attained to, made of importance, for the first time, such differences of foods as necessitated different kinds of teeth for masticating them. Examined in this respect, the food ordinarily made use of by mammals may be roughly divided into five classes—fruits, insects, flesh, grass, and hard foods—and these have led to the formation of the five great orders: primates, insectivores, carnivores, ungulates, and rodents. The importance of these food characteristics in modifying mammals may be seen when it is stated that these five orders, with the bats, which are flying insectivores, contain five sixths of the mammalian species and probably more than nineteen twentieths of all the individuals of the class. Again, the becoming fitted for hard foods, by the rodents, brought them under the influence of a new set of surroundings, namely, the various locations in which such foods existed, and the families of squirrels, mice, hares, beavers, etc., are the result. The same process again took place in the formation of the genera and species of these families.

We must look upon the class, order, family, genus, and species characters of each individual animal as structures which fit it or have fitted its ancestors for as many distinct facts of environment. The later gained and more trivial structures may overlie and obscure the more ancient and fundamental ones, like the later writings on an old palimpsest, but all are to be made out by the skillful anatomist. As has been said, the line of modification is not always a direct one, but it is often so deflected that structures which were primarily adapted to one fact of environment may be modified secondarily to fit them for others which are opposed and antagonistic to the first. The

examples of swimming and running birds without flight, and of marine and aërial mammals, have already been given. In these cases, the fundamental structures become in part worn and mutilated, and some of them entirely lost. Some of the running birds have lost a large part of the bones of the wing, and the whales have lost the hinder limbs. Such mutilation and loss of parts is proof that the animal which has suffered them has departed from the environment of its ancestors.

But though deflection and antagonism of structures is possible and frequent, it is necessarily not usual; later modifications of structures are ordinarily in harmony with more fundamental ones, and later conditions of environment with primary ones. Progress is ordinarily easiest in a straight line. Most fishes live in the water and swim, though they become variously modified for the various secondary conditions found in this medium. Most birds fly, though they are subjected to endless modifications which are in harmony with flight. The mass of shot show the spot aimed at, and not the scattering pellets. When later modifications are in agreement with primary ones, the primary structures remain in full perfection and use.

The facts of environment bearing upon life are so various and so heterogeneous that they allow of but little classification. Those conditions which have existed pretty generally over the earth, and with little or no change since the creation of life, have had the most profound modifying influence. Among these are the different mediums respired, air and water, and the different horizons or locations requiring peculiar organs of locomotion, deep and shallow water, earth, rocks, and trees, and air. The divisions of types which are usually dignified by systematists with the title of classes have their reason for existence in conditions of this kind. The five recognized classes of vertebrates—fishes, amphibians, reptiles, birds, and mammals—are simply modifications of type for life in water, in shallows, on land, on trees and rocks, and in the air.

But these conditions are not confined to this first influence upon the types. Being in continual and unchanged existence, they again had their influence, among other conditions, in forming the secondary divisions of the type, that is, the groups called orders, and have caused many or all of the deflections of these from the class-lines of structure. In the mammals the order of whales and bats, and in a less degree the ungulates, are cases in point. Among the birds, the ostriches, with the ordinary wading, running, and swimming birds, are examples. Even in the orders the influence of these great primary conditions is not lost, but with less and less power, as the specializations of family, genus, and species are reached, they still show their force in

such families as the beaver, in such genera as the otter and muskrat and flying-squirrel, and in such species as the water-hare of the Southern States.

In addition to the class of conditions above mentioned which have led to fundamental differences of breathing organs and of organs of locomotion especially, there are others which have had a much more superficial effect in modifying life. These are such as foods, enemies, climate, and perhaps others too subtile to be known at present. These differ from the first in having come into existence, many of them, since the creation of life, and in having been in a continual state of change. The groups called orders, families, genera, and species, depend on these in most cases for their reason for existence. The structures modified lead to differences of size, color, shape, teeth, or other organs of food-taking, and secondary modifications of the organs of locomotion. Like the first class of conditions mentioned, these may also by their continual existence cause modifications in other groups than those especially and primarily fitted to them. The primates are fruit-eaters and the bats are normally insect-eaters; but the fruit-bats are secondarily modified in teeth, size, stomach, etc., for fruit-eating.

The groups founded on these secondary and changing conditions have also been in a corresponding state of change, old forms disappearing and new ones taking their place. Where facts of this second class have approached stability, the groups corresponding have partaken of this character in the same degree. The foods which became such important factors in the modification of mammals must have at a very early period taken on the general characters of fruits, flesh, insects, grass, and hard substances, and the great orders were at an early period formed and have remained, and must do so while the earth exists in anything like its present state.

Many of the so-called families are also based upon conditions which have a good degree of permanence; but as the lesser groups are approached the facts of environment upon which they are established become more and more narrow and more capable of either destruction or change. While the general class of hard foods may remain as long as terrestrial life exists, particular kinds of nut-trees or of grains may disappear, and with them species and even genera depending upon them for existence. As the conditions leading to the formation of the lesser groups grow more narrow in their character, being limited perhaps by a single species of food, the location in which this condition exists becomes restricted also, and so the chances for its destruction are increased. But very many of the changes among the ultimate groups are not by destruction, but by change of the conditioning

environment slow enough to be accompanied by change of the species depending upon it. There can be but little doubt that many if not most or all of existing species are slowly changing in mass and in place into something else than what they are now. This process may be so slow that it will require some such careful study and delicate calculation as has been used by astronomers to prove that the so-called fixed stars are in motion; but the well-founded belief that geological changes are still going on upon the earth is enough to make us certain that changes in living things must accompany these or follow close after.

In addition to such slow changes of the mass of individuals of a species as must finally produce a form specifically different from it, there is another method of formation of species which would seem to be much more prolific in its results, and which alone can keep the earth populated during ages of changes of environment, some of them so rapid and violent that they destroy great numbers of species. This is by the migration of individuals into surrounding areas where the conditions are so near like those to which they are accustomed that they can exist, and still different enough to set up rapid changes of structure. The offshoots of the parent species might thus become numerous, and still retain likeness enough to each other so that they would be thrown by the systematist into a common genus; or, if the changes of environment were less, we should have a set of subspecies or varieties. There is no line or rule fixed in nature by which we can say that this is a genus with several species, and this is a species with several varieties. If this is a true theory for the creation of species, there should exist certain species settled and fixed in character, which have existed with but the slow modifications of structures caused by geological changes, while other species would be ready to change in any direction, or to revert rapidly to the characters of its parent species. The varieties and species of man's make are exaggerated examples of the latter class, and man himself would furnish illustrations of the same thing in such ancient and well-established species as the Chinese, and such a recently-formed variety as the Anglo-American. The heterogeneous character of the conditions of environment bearing upon life, and their utter lack of equality or equivalence of modifying power, give good and sufficient reason for that lack of equality of structural values among groups, which is best shown by the inability of the best systematists to agree upon their value. The fate of the group called species is a case in point. As long as the animals of a single well-defined area were studied, there was no difficulty, for closely-allied species necessarily rarely or never inhabit the same area; but as soon as the study became comparative, by bringing in forms from neigh-

boring areas, species lost its significance as a term of fixed meaning, and can not be separated from genus on one side and subspecies or variety on the other.

Though the examples made use of in this discussion are taken from the vertebrate type of animals, the other great divisions fall under the same law, each in its own way, and under limitations set by the characters of the types themselves.

THE IMITATIVE FACULTY OF INFANTS.*

By Prof. W. PREYER.

TO determine as exactly as possible the date of the first imitative acts is of especial interest in regard to the genesis of mind, because even the most insignificant imitative movement furnishes a sure proof of activity of the cerebrum. For, in order to imitate, one must first perceive through the senses; secondly, have an idea of what has been perceived; thirdly, execute a movement corresponding to this idea. Now, this threefold central process can not exist without a cerebrum, or without certain parts of the cerebrum, probably the cortical substance. Without the cerebral cortex, certain perceptions are possible, to be sure; many movements are possible, but not the generation of the latter out of the former. However often imitation has the appearance of an involuntary movement, yet when it was executed the first time, it must have been executed with intention—i. e., voluntarily. When a child imitates, it has already a will. But the oftener a voluntary movement is repeated, always in the same way, so much more it approximates reflex movement. Hence many imitative acts, even in the child, occur involuntarily quite early. But the first ones are willed. When do they make their appearance?

If we make, for the infant to see, a movement that he has often practiced of his own accord, he can make a successful imitation much earlier than is commonly supposed. Such a movement, which I employed as suitable for early imitation, is the *pursing of the mouth*, the protruding of the closed lips, which often occurs (even in adults), along with a great strain of the attention.

This protruding of the lips occurred with my child on the

* From "The Mind of the Child: Part I. The Senses and the Will." Being observations concerning the mental development of the human being in the first year of life. By W. Preyer, Professor of Physiology in the University of Jena. Translated from the German by H. W. Brown, with an Introduction by G. Stanley Hall. New York: D. Appleton & Co., 1888.

tenth day of life (in the bath, when a burning candle was held before him at the distance of a metre); in the seventh week it was decidedly marked at sight of a new face quite near him; in the tenth week, at the bending and stretching of his legs in the bath. It was as if the letter *u* were to be pronounced—and yet the child was wholly unable to imitate this movement so easily made by him (as late as the fourteenth week) when I made it for him under the most favorable circumstances. At the end of the fifteenth week appeared for the first time the beginnings of an imitation, the infant making attempts to purse the lips when I did it close in front of him. That this was a case of imitative movement is shown by the imperfect character of it in comparison with the perfect pursing of the lips when he makes the movement of his own accord in some other strain of the attention. Strangely enough, the imitation was attempted on the one hundred and fifth day, but not in the following days.

Further attempts at imitation occurred so seldom and were so imperfect, notwithstanding much pains on my part to induce them, in the following weeks, that I was in doubt whether they might not be the result of accidental coincidences. Not till the seventh month were the attempts to imitate movements of the head, and the pursing of the lips already spoken of, so striking that I could no longer refer them to accidental coincidence. In particular the child often laughed when one laughed to him (p. 145). The attention is now more and more plainly strained when new movements are made for the infant to see—he follows these with evident interest, but without coming to the point of an attempt at imitation in a single instance. This indolence was the more surprising, as even in the seventeenth week the protruding of the tip of the tongue between the lips (customary with many adults at their work) was perfectly imitated once, when done by me before the child's face, and the child in fact smiled directly at this strange movement which seemed to please him. Imitative movements thus appear in the fourth month, which in the seventh, and even the ninth, do not succeed or are quite imperfectly achieved. Yet in the tenth month correct imitations of all sorts of movements were frequent, and it is certain that these were executed with distinct consciousness; for, when he is imitating movements of hand and arm frequently repeated before him—e. g., *beckoning* [in the general sense of making a sign] and saying—"Tatta"—the child looks fixedly at the person concerned, and then often suddenly makes the movement quite correctly.

Beckoning (*Winken*) is in general one of the movements of the infant acquired early by imitation. In my child it appeared for the first time at the beginning of the tenth month. When

he was going to be taken out, his mother used to make a sign to him, and now he likewise made a sign, almost invariably, in the doorway, with one arm, frequently with both arms, yet with an expression of face that indicated that he moved the arms or arm without understanding, upon the opening of the door. The proof of this lies in the fact that, when I enter the room, the child, so long as the door is in motion, makes that movement which he at first only imitated, and does it regularly—no hint of leave-taking in it, therefore. The beckoning movement is made also at other times—e. g., on the opening and shutting of a large cupboard; it has, therefore, completely lost its purely imitative character. The movement consists essentially of a rapid raising and dropping of the extended arm; it is not, therefore, genuine beckoning. Not till after some weeks were motions of the hand added, and this more skillful imitation made it seem as if the machine-like movements that were made at the opening of the door were less and less involuntary, were more and more intentionally performed as genuine signs of leave-taking. But at this period (tenth month) such an action is not yet admissible; for when I make the same beckoning movement for the child without opening the door, he repeats it often in a purely imitative fashion without deliberation, though, to be sure, the eye has an expression of great strain of attention, on account of the difficulty of comprehending so quick a movement.

Not every imitative movement can be so clearly perceived to be willed as can this one. When one enters a room in which there are a good many infants, all quiet, one can easily observe the contagious influence of crying. For, if only one child begins to cry, then very soon several are crying, then many, often all of them. So, too, when one single infant (in the ninth month) hears other children cry, he likewise, in very many cases, begins to cry. The older the child becomes, the more seldom appears this kind of undesirable imitation; but even in children four years old, quite aimless imitative movements may often be perceived (as in mesmeric patients) if the children are observed without their knowledge. For example, they suddenly hold the arms crossed, as a stranger present is doing, and bow as he does at leaving.

A little girl in the last quarter of her first year imitated, in the drollest fashion, what she herself experienced in her treatment by the nurse, giving her doll a bath, punishing it, kissing it, singing it to sleep; and before the end of the first year she imitated the barking of the dog and the bleating of the sheep (Frau Dr. Friedemann).

Another female child imitated the following movements in a recognizable manner: in the eleventh month she threatened with

the forefinger if any one did so to her, used a brush after she had seen brushes and combs, used a spoon properly, and drank from a cup, and made a kind of cradling movement with her doll, singing, "Eia—eia." In the thirteenth month the child made the motion of sewing, of writing (moistening the point of the pencil in her mouth), and of folding the arms. In the fifteenth month she fed the doll as she was fed herself, imitated shaving, on her own chin, and reading aloud, moving her finger along the [lines and modulating her voice. In the eighteenth month she imitated singing, and made the motion of turning a crank like a hurdy-gurdy player when she heard music; in the nineteenth she went on hands and feet, crying "Au, au!" (ow, ow), in imitation of a dog; in the twentieth she imitated smoking, holding a cane firmly with her fingers exactly as is done in smoking a pipe. Her younger sister, in her fifteenth month, first imitated the movement of sewing and of writing; while the elder, in the nineteenth month, after repeated attempts at imitation, sewed together two pieces of cloth, without instruction, drawing the needle through correctly (Frau von Strümpell).

Toward the end of the first year of life the voluntary imitative movements, more numerous than before, are executed much more skillfully and more quickly. But when they require complex co-ordination they easily fail. When (at the beginning of the twelfth month) any one struck several times with a saltspoon on a tumbler so that it resounded, my child took the spoon, looked at it steadily, and then likewise tried to strike on the glass with it, but he could not make it ring. In such imitations, which are entirely new, and on that account make a deeper impression, as in the case of puffing (*Pusten*), it would happen that they were repeated by the child in his dreams, without interruption of his sleep (twelfth month), a proof that the experiences of the day, however unimportant they appear to the adult, have stamped themselves firmly upon the impressionable brain of the child. But it takes always some seconds before a new or partly new movement, however simple, is imitated, when it is made for the child to imitate—e. g., it was a habit of my child (in the fourteenth month) to move both arms symmetrically hither and thither, saying, "ay—ĕ, ay—ĕ" (altogether differently, much more persistently and rapidly, than when beckoning). If some one made this very swinging of the arms for the child to observe, with the same sound, there was always an interval of several seconds before the child could execute the movement in like fashion. The simplest mental processes of all, therefore, need much more time than they do later. But imitations of this kind are almost always performed more quickly when they are not sought, when the child-brain is not obliged first to get its bear-

ings, but acts spontaneously. If I clear my throat, or cough purposely, without looking at the child, he often gives a little cough likewise in a comical manner. If I ask, "Did the child cough?" or if I ask him, "Can you cough?" he coughs, but generally copying less accurately (in the fourteenth and fifteenth months). The bow too tightly strained shoots beyond the mark.

Here, besides pure imitation, there is already understanding of the name of the imitated movement with the peculiar noise.

This important step in knowledge once taken, the movements imitated become more and more complicated, and are more and more connected with objects of daily experience. In the fifteenth month the child learns to blow out a candle. He puffs from six to ten times in vain, and grasps at the flame meantime, laughs when it is extinguished, and exerts himself, after it has been lighted, in blowing or breathing, with cheeks puffed out and lips protruded to an unnecessary degree, because he does not imitate *accurately*. For it can hardly be that a child that has never seen how a candle can be blown out would hit upon the notion of blowing it out. Understanding and experience are not yet sufficient to make this discovery.

I find, in general, that the movements made for imitation are the more easily imitated correctly the less complicated they are. When I opened and shut my hand alternately, merely for the purpose of amusing the child, he suddenly began to open and shut his right hand likewise in quite similar fashion. The resemblance of his movement to mine was extremely surprising in comparison with the awkward blowing out of the candle in the previous instance. It is occasioned by the greater simplicity. Yet, simple as the bending of the finger seems, it requires, nevertheless, so many harmonious impulses, nerve-excitements, and contractions of muscular fibers, that the imitation of simple movements even can hardly be understood without taking into account the element of heredity, since unusual movements, never performed, it may be, by ancestors—say, standing on the head—are never, under any circumstances, imitated correctly at the first attempt. The opening and shutting of the hand is just one of the movements by no means unusual, but often performed by ancestors. Still, it is to be noticed that at the beginning the imitation proceeded very slowly, although correctly. On the very next day it was much more rapid on the repetition of the attempt, and the child, surprised by the novelty of the experience, now observed attentively first my hand and then his own (fifteenth month).

Of the numerous more complicated movements of the succeeding period, the following, also, may be mentioned, in order to show the rapid progress in utilizing a new retinal image for

the execution of an act corresponding to it: A large ring, which I slowly put on my head and took away again, was seized by the child, and put by him in the same way on his own head without fumbling (sixteenth month). But, when it is a case of combination of a definite action of the muscles of the mouth with expiration of the breath, innumerable fruitless efforts at imitation are made before one of them succeeds, because, in this case, a part only of the working of the complicated muscular action can be perceived, while the rest must be found out by trial. Thus, the child could not, in spite of many attempts, get any tone out of a small hunting-horn. He put it to his mouth, and tried to imitate the tone with his own voice. Suddenly the right manner of blowing was hit upon accidentally, and from that time was never forgotten (eighteenth month).

After the child had seen how his mother combed her long dark hair before a glass, he took a hand-mirror and a comb and moved the comb around on his head, combing where there was no hair. So, too, he would now and then seize a brush and try to brush his head and his dress, but took special pleasure in brushing also all kinds of furniture. More than once he actually took a shawl, held it by a corner to his shoulder, and drew it behind him like a train, frequently turning around while doing this. He also put a collar round his neck; he tried to dry himself with a towel, but without success; whereas the washing of the hands with soap, without direction, was imitated, though not with much skill, yet tolerably well; none but very complicated imitative actions these, and all of them, in the case of my boy, belong to the third quarter of the second year—an exceptionally important period in mental genesis—the same is true of seizing, holding things before him, and (what was observed by Lindner in the sixth month) the imitation of reading aloud from a newspaper or pamphlet, the feeding of deer—holding out a single spear of grass to them—scraping the feet upon entering the house (as if the shoes were to be cleaned).

But how little real imitation and understanding of the act itself there was, even in this period of perfect external imitations, appears from the circumstance that a map is held, as a newspaper, "to be read aloud," before the face, and upside down. Now, too, the child likes to take a pencil, puts the point in his mouth, and then makes all sorts of marks on a sheet of paper, as if he could draw.

Just as remarkable is the lively interest in everything that goes on in the neighborhood of the child. In packing and unpacking, setting the table, lighting the fire, lifting and moving furniture, he tries to help. His imitative impulse seems here almost like ambition (twenty-third month).

Toward the end of the second year various ceremonious movements, especially those of salutation, are also imitated. The child sees how an older boy takes off his hat in salutation; immediately he takes off his own head-covering and puts it on again, like the other boy.

All these movements last enumerated are distinguished from the earlier ones by this, that they were executed or attempted by the boy unsolicited, without the least inducement or urging, entirely of his own motion.

They show, on the one hand, how powerful the imitative impulse has become (in the second year); on the other hand, how important this impulse must be for the further mental development. For, if the child at this age passes the greater part of his time in company inattentive to manners, or unrefined, then he will imitate all sorts of things injurious to him, and will easily acquire habits that hinder his further development. It is, therefore, of the greatest importance, even at this early period, to prevent the intercourse of children with strangers, and to avoid everything that might open wrong paths to the imitative impulse.

The imitative movements of the muscles of speech, the child's imitations of sounds, syllables, and words are treated of in detail in the third part of this work. The first answer of the infant to the language addressed to him by his relatives, which is said to be made, in individual cases, as early as the eighth and ninth weeks (according to Sully, 1882), is no attempt at imitation, but a directly reflexive movement, like screaming after a blow, etc. Singing has already been mentioned as one of the earliest imitated performances. It is true of these, as of all later imitations, that the first imitation of every new movement is voluntary on the part of the child, and, in case an involuntary imitation seems to occur, then either this has already been often repeated as such, or it is a movement often practiced without imitation. The accuracy of the imitation depends little, however, upon the co-operation of a deliberative cerebral activity. On the contrary, children of inferior mental endowment among those born deaf sometimes possess (according to Gude) a purer and more distinct enunciation than those more gifted.

A REVISION of the calendar has been proposed by M. Gaston Armelin to the Astronomical Society of France, the object of which is to have the same day of the month always come on the same day of the week. He would divide the year into four quarters of ninety-one days or thirteen weeks each—making three hundred and sixty-four days—and would leave the three hundred and sixty-fifth day as a supplementary day, outside of and additional to the weekly and monthly reckoning. All the months should be uniformly thirty and thirty-one days each, their length being fixed so as to fit exactly into the three-monthly reckoning.

THE FLAME OF A CANDLE.

By C. FIEVEZ,

ASTRONOMER AT THE ROYAL OBSERVATORY AT BRUSSELS.

THE little yellow candle-flame, which is gradually disappearing from our households to give place to brilliant gas and electric lights, still plays a considerable part in the labors and researches of physicists, chemists, and astronomers. The former find in it a source of heat capable of melting and oxidizing or reducing the most refractory metals. The last employ it as a photometric unit, both to measure the most considerable lights and to determine the luminosity of stars so faint that they can hardly be seen in the great telescopes. But the most curious and interesting thing about this little flame is the fact that the optical study of it has contributed very largely to our knowledge of the elementary composition of the celestial bodies.

Carefully examined with the naked eye, the flame of a candle is composed of three distinct layers or envelopes, viz., a dark central part, the dark cone around the wick, formed of gaseous products of low temperature, and holding in suspension carbon in a state of fine division, but not yet incandescent; a luminous part, surrounding the dark part, and composed of carbon raised to a bright incandescence; and a thin external envelope, only faintly luminous and faintly colored, yellow toward the top, where the carbon is completely burned, and bluish toward the base, where the primary products of the decomposition of the matter of the candle are burning in contact with the air.

Analyzed by the aid of the spectroscope, the luminous cone gives a brilliant and continuous spectrum—that is, one having the appearance of a ribbon exhibiting all the colors of the rainbow, while the exterior, faintly luminous envelope gives a discontinuous spectrum formed of three bright bands—one yellow, one green, and one blue.

As only solid incandescent bodies are capable of giving a continuous spectrum, we conclude that carbon in the solid state is incandescent in the luminous envelope of the flame. But, the spectrum of the exterior envelope being discontinuous, we conclude that it is composed entirely of gaseous products.

The flame of illuminating gas presents, both to the naked eye and in the spectroscope, the same aspect as the flame of the candle, whence it is concluded that its lighting and heating powers are derived from the same cause—the more or less complete combustion of carbon.

By blowing air or injecting oxygen through the blow-pipe into a candle-flame or a gas-light, its aspect is greatly changed.

The bright envelope nearly all disappears, while the inner dark cone is considerably developed, reaches a very high temperature, and exhibits a spectrum identical with that of the outer cone of the original flame. The brightness of the spectral bands is augmented by the rising of the temperature, and two new luminous bands, a red and a violet one, become visible in the spectroscope. At this moment we recognize that these bands are composed of a series of rays or bright lines, separated from one another by dark spaces.

While performing the prismatic analysis of the inner cone of a gas-light flame fed with pure oxygen, M. Stas observed, with the same spectroscope, a spectrum sensibly different as to the number of rays constituting the bands, according as the observation was made upon the top of the inner cone, where the temperature is highest and sufficient to keep iridium in fusion, or on the front or the side of this inner cone. The physiognomies of these three spectra vary according to the spectroscope employed. If we use a spectroscope with direct vision and weak dispersion, we observe a spectrum resembling that of the candle-flame; but, with an instrument of more considerable dispersive power, the bands define themselves into brilliant rays, some fine, and others broad, having extremely clear edges. These facts, M. Stas remarks, inseparably connect the *facies* of the spectrum of the flame with its greater or less elevation of temperature, and with the analyzing instruments employed.

Although the luminous intensity of the inner cone of the oxyhydrogen-flame is quite weak, Mr. Piazzi Smyth has discovered more than 400 bright rays in the spectral bands of this cone; viz., 97 rays in the red, 94 in the yellow, 97 in the green, 107 in the blue, and 71 in the violet bands.

But it is the analysis of the electric arc, the light of which does not differ essentially from that of the candle—for it is also the result of the ignition of carbon—that shows us these spectral bands in all their splendor, and initiates us into the grand complexity of their constitution. Like a luminous ribbon passing insensibly from one shade to another with diminishing brilliancy, each band is composed of a considerable number of bright rays of different breadths, disposed with a wonderful symmetry, increasing with the power of the analyzing instrument and the luminous intensity of the electric arc; the broader bright rays doubling into finer rays, and new luminous rays appearing in the dark spaces that separate the bright rays. While these bright lines are not arranged rigorously in the same manner in each band, they nevertheless show a great resemblance in their grouping and spacing.

In order to show how far the resolution into bright lines of

the spectral bands of the electric arc (which are identical with those of the candle and the oxyhydrogen blow-pipe) may be carried, I have published a specimen of the *facies* of the yellow, green, and blue bands, indicating the intensity and normal distance of the rays composing them. It appears, from this work, that, for a fifth part alone of their total length, these bands show, respectively, 163, 160, and 120 lines; this would bring to about 800 the number of lines constituting each band, and to at least 4,000 the number of the lines forming the five bands of the spectrum of the electric arc; for the more intense bright lines are doubled again when they are observed under conditions favorable to their brilliancy and dispersion. In comparing, with the same spectroscope, the spectrum of the electric arc and the solar spectrum, we observe that the former spectrum displays a more considerable number of bright rays than the solar spectrum of dark rays. Since it is nearly certain that the spectral bands belong to the spectrum of carbon—for they are observed when the electric arc shines in a vacuum, that is, when carbon alone is in ignition—it follows that the spectrum of this element contains more rays than the entire solar spectrum.

Some physicists doubted for a long time the identity of the spectra of carbon and the candle-flame, because there existed a spectrum of carbon entirely different from the banded spectrum. But as I have succeeded in demonstrating, on the one hand, that this spectrum does not belong to carbon, and on the other hand that the spectrum of the candle-flame was brightly visible in the ignited filament of the incandescent lamp when the vacuum is as perfect as it is possible to make it, I think there should now be little doubt respecting the identity of the two spectra. Carbon, being found in various combinations everywhere on the surface of the globe, should of necessity reveal its presence in most of the bodies subjected to spectrum analysis. Eminent chemists have even found traces of it in the nearly perfect vacuum of our pneumatic machines.

The absorption spectrum of carbon, or that which should be composed of the dark lines detaching themselves upon a continuously bright spectrum, has not yet been obtained. In the comparative study that I have made of the solar spectrum and the spectrum of carbon, I have shown that most of the bright rays forming the carbon bands do not coincide with the dark rays of the solar spectrum. I have been inclined to believe from this that the absorption spectrum of carbon does not exist in the solar spectrum, but I have not been able to declare the same conclusion respecting the emission spectrum—that is, the spectrum with bright bands—because the discovery of the bright bands in the solar spectrum offers a real difficulty, resulting from the fact

that the bright rays can be recognized on the bright part of the solar spectrum only by the difference of their brilliancy. On the other hand, we have not recognized the presence of the emission spectrum of carbon among the numerous bright rays observed in the spectrum of the solar atmosphere; and this fact goes to indicate the absence of carbon among the constituent elements of the sun. But such an assertion can not be made until our acquaintance with the subject becomes more complete and clear.

Although it is hardly possible, in the actual state of our knowledge, to establish the presence of carbon in the sun, it is extremely easy to recognize it in the spectra of comets. In 1868, when the comets of Winnecke and Brorsen appeared, Secchi in Italy, Huggins in England, and Wolf in France, studying the spectra of those stars in respect to their composition, discerned that the three bright bands, yellow, green, and blue, of which they were formed, could be regarded as analogous with the spectrum of carbon. It is possible, in fact, in a gas-light re-enforced by oxygen, if the brightness of the flame is reduced and a spectroscope of feeble dispersion is used, to obtain a spectrum exactly like that of a comet. After these observations, Mr. Christie and myself recognized the violet band in the spectrum of the comet *b* of 1881, and Dr. Young has found that the green band, or the most brilliant one in the spectrum of this comet, is formed of rays like the corresponding green band of the spectrum of flame. The identity of the two spectra is therefore demonstrated.

The presence of carbon is also suspected, if not definitely recognized, in the spectra of certain stars, the orange or red color of which indicates a temperature of relatively inferior elevation. The spectra of these stars consist of several dark bands, superposed upon a continuous bright spectrum, which present a great similarity of aspect and position with the luminous bands of the spectrum of carbon in comets, illuminating gas, and the candle-flame. We have then, here, the absorption spectrum of carbon. The spectral analysis of the candle-flame thus permits us to discover by optical methods the presence of one of the most important elements of our globe in luminous bodies, whether celestial or terrestrial, whatever their distance, even though it be so great that light occupies thousands of years in coming to us.—*Translated for the Popular Science Monthly from Ciel et Terre.*

While generally accepting Mr. James Murray's views regarding the formation of barrier reefs and atolls, Mr. J. L. Wheaton would regard as the principal agent in forming the interior lagoons, not the solution and washing out of dead coral by sea-water, but privation of the inner part of the reef of food, all nourishment having been absorbed by the corals of the outer reef from the water before it reaches the interior.

SKETCH OF ALPHEUS SPRING PACKARD.

By Professor J. S. KINGSLEY.

THE influence which Louis Agassiz had in the development of American science is to be estimated not by his published works, but by the enthusiasm he instilled into all who came under his instruction. In the years from 1861 to 1864 there were gathered at Cambridge as his pupils eight men, each of whom has made a name for himself in science. These eight were Alexander Agassiz, Alpheus Hyatt, Edward Sylvester Morse, Alpheus Spring Packard, Frederick Ward Putnam, Samuel Hubbard Scudder, Nathaniel Southgate Shaler, and Addison Emory Verrill.

Alpheus Spring Packard, the subject of the present sketch, is one of the four sons of the venerated Prof. Packard who for over sixty years was connected with the faculty of Bowdoin College. He was born at Brunswick, Me., February 19, 1839, and at the age of eighteen entered the college where his father was a professor. While a student he evinced a marked predilection for natural history, a tendency which was fostered and encouraged by the late Dr. Paul A. Chadbourne, who at that time was a professor in both Williams and Bowdoin Colleges. At Williams there was a flourishing students' society, the Lyceum of Natural History, which at this time had sent out several scientific expeditions, and in the summer of 1860 they laid their plans for another, the objective points of which were Labrador and Greenland. When the expedition set sail from Thomaston, Me., young Packard joined it and went as far as Labrador, where he spent fifty days collecting near Caribou Island. The others went to Greenland, and on their return took him and his collections back to the States in time for him to begin the studies of his senior year. These, however, were not without interruption, for before graduation he led a party of classmates on a dredging and collecting expedition to the Bay of Fundy.

At commencement in 1861 Bowdoin gave him his bachelor's degree, and then the field was opened to him to follow his scientific bent. In the spring of that year the Legislature of Maine had authorized a scientific survey of the State, and Mr. Packard received the appointment of entomologist on the corps. In this capacity he accompanied a party who went up the east branch of the Penobscot and then down the Alleguash and St. John's Rivers as far as Woodstock. With the materials gathered on this expedition Mr. Packard wrote the first of that long series of scientific articles which have emanated from his pen. It was an essay on the army-worm, which at that time was doing considerable damage to agricultural interests in Maine. This paper,

with others by the same author, was published in the first report of the survey.

Mr. Packard had now fully decided to devote himself to zoology, and, in order to widen his views and increase his knowledge, he went to Cambridge to study with Agassiz. Here for three years he devoted himself to entomology and made such progress that during the latter part of the time he held the position of assistant. He laid a broad foundation for his future studies in entomology, and in a paper published in 1863, under the title "Synthetic Types in Insects," he introduced new views into the classification of these forms. From that date to the present time not a year has passed without numerous articles from his pen, a mere list of which would occupy more space than can be devoted to this sketch.

At the same time that he was studying zoölogy he was reading medicine and attending lectures during the winter term at the medical school connected with his Alma Mater, where in 1864 he passed the necessary examinations and received his doctor's degree. In the summer of the same year he set sail again for Labrador, this time in company with the marine artist Bradford, to collect materials for a memoir of the geology and natural history of that then little-known region. On his former trip he had visited only the southern portion of the coast. This time he went as far north as Hopedale, dredging at favorable localities along the shore, and everywhere paying attention to the geology and especially to the former traces of glacial action.

The results of this trip were not, however, to be immediately worked up, for on his return to Brunswick he enlisted for three years as assistant surgeon in the First Regiment of Maine Veteran Volunteers, and marched away to join the Army of the Potomac. While in Virginia the scientific passion ruled strong, and many an insect fell a victim to the collecting-bottle. Fortunately, before the three years for which he enlisted were over, the war came to an end, and Dr. Packard was mustered out in July, 1865, after a military and medical experience of ten months.

He now returned to Boston, and for a while acted as librarian and custodian at the Boston Society of Natural History, at the same time working up the results of his Labrador explorations, which were published as a memoir by the Boston Society of Natural History in 1867, and which still remain the chief source of our knowledge of the fauna and geology of that region. The stay in Boston was, however, of short duration, for at this time the Essex Institute, at Salem, Mass., was displaying great activity in the line of natural history, and negotiations were in progress with the London banker, George Peabody, looking toward an endowment for science in Essex County. These plans rapidly

took such shape that the Institute thought it advisable to increase its scientific force, and so in 1866 it called to Salem four of the students mentioned in the opening paragraph—Packard, Putnam, Morse, and Hyatt—as curators of the Institute collections. These plans, however, took a different turn from that expected by some, and the result was an independent institution, the Peabody Academy of Science, with an endowment of $140,000. The Institute turned over its collections to the new corporation, and with them went the four curators. They retained their connections with the Academy for varying lengths of time. Prof. Hyatt was the first to leave, as he was offered the position of custodian of the Boston Society of Natural History. Prof. Morse left next, and went to Bowdoin College as Professor of Zoölogy. Prof. Putnam, in 1876, was appointed Curator of the Peabody Museum of Archæology and Ethnology at Cambridge, another institution which owed its existence to the liberality of Mr. Peabody. Dr. Packard retained his connection with the Peabody Academy of Science until 1878, when he resigned to accept the professorship of Zoölogy and Geology in Brown University, a position which he holds to the present time.

These twelve years at Salem were prolific in work, only a small fraction of which can be noticed. Possibly the most important service done American science was the foundation of the "American Naturalist," a popular magazine of natural history, by Messrs. Packard, Morse, Hyatt, and Putnam, in 1867. With this journal Dr. Packard was connected, a part of the time as sole editor, for twenty years, only severing his connection with it in the beginning of the year 1887. It is difficult to overestimate the value of Dr. Packard's editorial labors, and it is certainly safe to say that if we consider this point alone no one has done more to shape American zoölogical science than he. Dr. Packard, however, did other work. He had continually several irons in the fire. Entomology was his chosen field, and, perceiving the lack of any manual for students in this department of science, he published in 1869 the first edition of his well-known "Guide to the Study of Insects," a volume which to this day is without a rival. It may be said, parenthetically, that Dr. Packard is now engaged in completely rewriting this work so that it may adequately represent the entomological science of the present time. The same years also witnessed the publication of various systematic and embryological papers, the principal one of which was an account of the development of that ancient form, the horseshoe crab.

The old spirit of exploration was not extinct. Scarcely a year passed without a trip to some point near or remote, the features of which he wished to study. In the winter of 1869–'70 he vis-

ited Key West and the Tortugas for the purpose of studying a tropical marine fauna, and from which he brought back large collections of marine invertebrates to swell the museum of the Peabody Academy of Science. On his return he stopped for a while at Beaufort, N. C., since made so celebrated as a zoölogical center by the labors of Dr. Brooks and his students, but which at that time was scarcely known. The next winter another Southern trip was taken—this time to Charleston, S. C., where some weeks were spent in the study of marine embryology, the results of which are still almost entirely in manuscript.

As is well known, a large proportion of the animals and plants of the United States were first scientifically described in Europe from specimens sent from here there by early collectors. The specimens which form the basis of these descriptions ("types" they are called) are scrupulously preserved in the museums, and it often becomes necessary for the naturalist to consult them to ascertain exactly what species some previous student had before him when he wrote the description which is not sufficient to identify the species. So Dr. Packard found it necessary to visit Europe, in 1872, to see for himself the insects described by the older European entomologists, and the result of the trip was considerable changes in the names of many of our butterflies and moths, for, according to the rules of zoölogical nomenclature, the first name applied to a species is the name that must hold. All the changes which prove so vexatious to the beginner, and for which it is not always easy to see the reason, are but steps toward permanence. By and by each species will be known by the name first given it, and then there will be no more of that tossing from pillar to post.

During the years 1871–1873 Dr. Packard held the position of State Entomologist of Massachusetts, and lectured at both the Maine and Massachusetts Agricultural Colleges upon the subject of economic entomology; but as these positions were very economically managed by the States, and were offices of honor rather than profit, they were resigned the latter year. In 1871 and 1872 he had written a small book in connection with Prof. Putnam upon the animals found in the Mammoth Cave, and then laid the foundation for that interest in the origin and effects of cave-life which is soon to come to fruition in an extensive memoir on the subject. As a result of this book he was appointed an assistant, in 1874, on the Kentucky Geological Survey, then under the charge of his former fellow-student, Prof. Shaler, and directed to make a thorough exploration of the Kentucky caves. The next two years he held the position of assistant zoölogist on the United States Geological and Geographical Survey of the Territories, under the charge of Prof. F. V. Hayden, and in that

capacity visited several of the Western Territories, and published a large quarto memoir on the family of geometrid moths, familiar examples of which are those forms the larvæ of which are known as canker-worms.

The year 1873 witnessed the establishment of the Anderson School of Natural History on the illy adapted island of Penikese, and here for two summers (the whole period of the existence of the school) Dr. Packard gave the instruction in the articulates. When the Penikese experiment was abandoned, the idea of a summer zoölogical station where students could come for the summer and pursue a course of study was taken up by the Peabody Academy of Science, which for five years maintained such a school. During the first three years of the existence of this Salem school (1876–'78) Dr. Packard was at its head, giving lectures, assisting in demonstrations, and in every way trying to make it a success.

The years from 1873 to 1876 will long be remembered by the inhabitants west of the Mississippi, from the terrible devastations of the Rocky Mountain locust, or grasshopper, as it is more familiarly known. Over enormous tracts of country everything green was devoured by these insect pests, and an enormous amount of suffering was caused by the destruction of the crops of the farmers. Indeed, so serious were the ravages that Congress was implored to create a commission of eminent entomologists to seek some way to check the locusts and to prevent their ravages. Congress passed the desired bill, and the Secretary of the Interior appointed, as the United States Entomological Commission, Prof. C. V. Riley, Prof. Cyrus Thomas, and Dr. A. S. Packard. If the logic of *post hoc, ergo propter hoc,* be valid, no better appointments could have been made, for the very year these persons began their duties the locust troubles were very materially diminished. The three members of the commission divided the field between them, and Dr. Packard made several trips to the Territories to study the extent of the locust ravages, and to ascertain their breeding-grounds. One of these trips took him to California, Oregon, and Washington Territory. As has been said, the locust invasions ceased almost the moment the commissioners were appointed, but other insects became serious pests in other parts of the country, and so Congress enlarged the scope of the commission, and directed its members to investigate the chinch-bug, the Hessian fly, and the cotton-worm, and limited the duration of the existence of the board to five years. The commission have published three annual reports, large octavo volumes, filled with information regarding various destructive insects, besides numerous smaller bulletins. They have another and final report now in press.

In 1878 Dr. Packard received the appointment of Professor of Zoölogy and Geology in Brown University, at Providence, R. I., a position which he holds at the present time. Here, besides his duties as teacher, he has found time to conduct various investigations, besides writing three text-books of zoölogy, all of which have met with an extensive sale. In the spring of 1885 he found time to take an extensive trip through the Southern States and Mexico, "doing" the latter country in a manner not common since the completion of the Mexican Central Railway. He cut loose from the steam-horse and trusted himself to the old-fashioned diligence, traveling thus across the country in a more leisurely manner, and seeing far more of it and of its inhabitants than can be seen by the ordinary excursionist from the window of a railway-car.

In 1867 Dr. Packard was married to Elizabeth Derby, the daughter of the late Samuel B. Walcott, of Salem, Mass. He has four children.

Such in outline is the life of Prof. Packard. Of his writings we have said but little, chiefly from inability to choose from their number. That their merit has been recognized by scientific men is shown by the numbers of societies which have conferred the distinction of honorary membership upon him. A complete bibliography of his writings has recently been prepared; but, in addition to those already mentioned in the present article, we may call attention to a few of the more prominent works. In 1873 and 1876 respectively he published "Our Common Insects" and "Half-Hours with Insects," two popular works on entomology. In the latter year he also published "Life Histories of Animals," which was the first compendium of all the known facts in the development of the animal kingdom, a work which has, however, been largely superseded by the more extensive "Comparative Embryology" of the late Prof. F. M. Balfour. In 1883 appeared his monograph of the "Phyllopod Crustacea," an account of a small group of animals which reach their greatest development in America. For several years he contributed the zoölogical notes to the scientific departments of "Harper's New Monthly Magazine," and of the "New York Independent." Of late years his studies have taken a turn in the line of the philosophy of zoölogy rather than in that of the description of species and the identification of specimens. He is now more interested in the structure and growth of animals, and the principles which underlie their distribution in space, than in the details of museum work.

Personally, Dr. Packard is a very pleasant and entertaining companion, and not least among his good qualities is the interest he takes in all who show any predilection toward scientific work.

These he is always ready to assist and encourage to the extent of his ability. As will be seen from the foregoing sketch, he is an indefatigable worker, and, to the brief notices of his articles given above, space will only allow a few other references to the discoveries he has made and the theories he has advanced in the various lines of zoölogical and geological research.

When Agassiz came to this country, he brought with him not only an interest in zoölogical subjects, but, as well, that enthusiasm which made his name famous in connection with the study of glaciers. He pointed out the existence of local glaciers in the White Mountains, but Dr. Packard traced out further than ever before the extent of this local system, following these rivers of ice from Mount Washington and the adjacent peaks down the valleys of western Maine. This work on glaciers was still further elaborated in his large memoir on Labrador, mentioned above, and led to other speculations of a zoölogical rather than of a purely geological character.

These were that the existing insect fauna of at least the Northeastern United States had its origin from a circumpolar Tertiary fauna. The facts for this conclusion were in part the following: Oswald Heer and Dr. Asa Gray had conclusively shown that the plants of the same region had thus originated, the Tertiary rocks of Greenland containing many genera which are characteristic of the American flora of to-day. Now, as is well known, there is the most intimate connection between the distribution of many insects and the plants on which they feed, and the habitats of many insects can only be accounted for upon some such supposition. For these in detail the student should seek Dr. Packard's "Monograph of the Geometrid Moths," but we can mention one instance. Certain butterflies and moths are known to-day only from the colder regions. They are found in Labrador and farther north, while in the United States they only occur in the widely separated mountain-regions of New Hampshire and Colorado. These, it is assumed, must have lived near the edge of the great continental ice-sheet of glacial times, and must have occurred in all the intervening extent of country. As the ice retreated and the territory became warmer, the plants on which the larvæ fed could only find conditions favorable to their existence on these high mountain-regions or the isothermal but lower lands of Labrador. This view of the origin of the fauna of the United States has since been adopted by many writers, and receives its most complete exposition in Dr. A. R. Wallace's "Geographical Distribution of Animals," but without credit to Dr. Packard, who advanced it several years before.

In morphological work, the studies on the development of the sting of the bee must be mentioned. Dr. Packard pointed out

twenty years ago—Dr. Kraepelin has since worked over the subject—that the sting of the bees and wasps is an organ composed of modified limbs, and is to be regarded as homologous with the organs which, in other insects, are devoted solely to reproductive functions. These points he carried out so that he could trace every portion of the one in the physiologically very different organ of the other.

The last of the studies which we can allude to are those of the development of *Limulus*. Dr. Lockwood, the first to study the subject, pointed out the similarity of the young horseshoe crab to the trilobites, and this Dr. Packard elaborated in his more extensive paper. His studies in this direction led him to investigate the ancestry of the king-crab, and he now has in press an extensive memoir on the fossil king-crabs, in which the subject will receive still further treatment, and will, no doubt, present many new views based upon the study of extensive suites of specimens.

Lives like this of Dr. Packard are of interest, not only in themselves, but as instances of heredity. Dr. Packard's father was a man of mark, as every graduate of Bowdoin will testify; while his grandfather Packard — a Revolutionary soldier — was a graduate of and a tutor in Harvard College. His maternal grandfather was the Rev. Dr. Appleton, formerly President of Bowdoin College. With such an ancestry, is it to be wondered that three of the sons should rise to eminence as college professors, while the fourth should become a prominent physician ?

EDITOR'S TABLE.

CONGRESS AND INTERNATIONAL COPYRIGHT.

IF it were charged that under our system of government measures of interest to the whole people, particularly such as might chiefly concern their intellectual and moral welfare, were apt to receive less attention from the Legislature than measures of purely local concern, we fear that the action of Congress up to the present in the matter of international copyright might be cited as a striking case in point. For many years past the thinking men of the country, those who give it its intellectual standing among the nations of the world, have been urging the necessity, both as a matter of national self-respect and also as one vitally affecting our intellectual growth, of the enactment of an international copyright law. Congress, however, in its zeal for "appropriations" and for party strategy, saw nothing in this demand to commend it to any special attention. On the contrary, the question raised was not one that seemed to come at all within the range of practical politics. Had the promoters represented one party in the state, and had they been able to show that they were organized for effective party warfare, they would have got a respectful hearing at least from the side they supported. But no; they

belonged to both parties, and some of them perhaps had the audacity to belong to neither, and in general they were not conspicuous in the caucus or famous for their knowledge of ropes and wires. They were simply American citizens, eminent for character and ability, pleading a cause in which not they alone but the whole people were concerned, and in which, so far as they themselves were personally interested, they had a case as strong as justice and common sense could make it. All this availed but little to conquer the indifference of Congress to a proposition that could not be expressed in terms of "politics."

There was a little more than indifference in it, however. The proposition was that this country should cease to appropriate without compensation the literary goods of foreigners, particularly of the British; and this did not fall in with those considerations of expediency which are so likely to influence the attitude of our legislators toward moral questions. How could the representative excuse himself to his constituents for making anything dear in the interest merely of abstract justice and of the higher intellectual development of the country at large? It was also the case that certain organized interests were arrayed against the principle of international copyright. There was no little opposition to it among publishers, printers, stereotypers, engravers, etc., who thought they saw in it the threat of a serious diminution of business. It is no wonder, therefore, that Congress should have put the matter off from year to year; the only wonder, indeed, is that those who believed in the principle should have had the courage to go on and should now by dint of patient persistence be in a position to present to Congress a stronger case than ever—one that can only be put aside through the most extreme and culpable indifference to an issue which affects, not the balance of parties, but the higher life of the whole people.

As the matter stands now, there is substantially but one opinion among publishers and authors in regard to the copyright question. The consideration of justice to foreign authors remains, of course, as before, neither stronger nor weaker; but careful reflection has led the great majority of those interested in the publishing trade to see that, in this case, justice to the foreigner means advantage to themselves. The stimulus that would be given to domestic literary production by the granting of copyright to American editions of foreign works would admittedly be very great; and, as the author can do nothing without the printer and publisher, these would share the benefit with him. There are bills now before both houses of Congress—the House bill being a copy of that introduced into the Senate by Senator Chace, of Rhode Island—providing for the extension of copyright privileges to foreigners on condition that the work for which the privilege is sought is published simultaneously in the United States and in the country of origin. Proof of publication will be the filing of two copies of the best American edition of the work in the office of the Librarian of Congress. Upon the granting of copyright to a foreign work, the importation of all foreign editions of the work in question, save with the consent of the holder of the copyright, is interdicted. These are the principal provisions of the measure, and it will be seen that they do justice to all interests concerned. They also appear to commend themselves to those members of Congress who have given the subject most attention, as the committees of both Houses having the matter in charge reported, without a dissenting voice, in favor of the bill. Congress, therefore, has now an opportunity of doing the country a triple service: 1. Removing the stigma which attaches to the

United States as the sole country claiming to be civilized which disregards the proprietary rights of foreign authors. 2. Greatly extending and improving the field for native authorship. 3. As the result of the two preceding benefits, raising the moral and intellectual tone more or less of the whole people. We may add, as a fourth benefit, the placing of the whole publishing trade of the country on a sounder footing.

The Popular Science Monthly has, from the first, placed itself on the right side of this question by consistently contending for the principle of international copyright, and that without any such reserves in regard to magazine literature as some members of Congress are now disposed to make, and such as it might be supposed to be in the interest of a periodical reprinting more or less from foreign sources might be thought to favor. Our interest in the subject, therefore, is not new-born, but is merely the continuation of that we have both felt and expressed whenever the question has been prominently before the public. In supporting the bill now before Congress, we do not wish to be understood as claiming that it is a perfect measure, or that it may not, after some experience of its working, be found to need amendment. All that can fairly be asked of a new law is that it should affirm a sound principle, and should provide the means for carrying that principle into more or less effective and satisfactory operation. This, however, may be claimed for the Copyright Bill—that it is no hole or corner measure, no product of selfish machinations against the general interest, but that all it aims at is for the public good.

MATTHEW ARNOLD.

Matthew Arnold, though pre-eminently a man of letters, was one who in many points occupied common ground with the men of science. He had that openness of spirit and that constant desire to search out causes which are among the best characteristics of the scientific temper. He had turned aside as completely from catastrophism in human history as modern geologists have done in regard to the physical history of the globe, or modern biologists in regard to the development of life. He may at times have weaved rather fanciful theories of his own, but he was always willing to bring them to the tests of fact and logic. Though not lacking in self-confidence, he was far from being dogmatic, and he invariably treated opponents not only with respect, but with unfailing kindliness. He had, perhaps, an inadequate appreciation of the value of certain lines of scientific investigation, and, conversely, he may have formed an exaggerated estimate of the value of the literary element in education; but every man must be allowed, as the French say, to preach his own saint; and Matthew Arnold's preaching had always something instructive in it. No man, it is almost needless to say, could write more interestingly than he; and this was doubtless because, with his fine gifts, he took life seriously, and applied his mind earnestly to some of its greatest problems. Allowing for all deficiencies and for a few mannerisms, he was a sound and wholesome thinker, and a useful man in his generation. There can be no doubt that, in his own way, he powerfully aided the great scientific movement of the age. No mind that fell under Matthew Arnold's influence could be closed against scientific conceptions, or could to any serious extent undervalue the work of science; and many must have owed to his vivacious pen their first realization of the extent to which modern thought had invaded and dismantled the fortresses of ancient prejudice. By his poetry, too, he succeeded, perhaps without intending it, in showing that modern thought is not destitute of the instinct for beauty, and that it lends itself in an especial manner to the delineation of the beauty of righteousness. We are not sure that

any poet of our time has spoken so directly to the consciences of the more enlightened portion of his contemporaries as Matthew Arnold. If, as the Roman poet has said, "there are tears in things," so also are there deep and grave admonitions, earnest pleadings, ever a voice for those who will hear, calling to man to walk in the light and realize the bliss of moral freedom. Mr. Arnold has made himself the interpreter to us of the truth of things, and this is what gives his poetry its acknowledged weight and value despite its somewhat restricted imaginative range. To read it is to commune with Nature, not with human authority. Carlyle talks of the "eternities" and "immensities." Mr. Arnold does not talk of them, but he brings us into their presence—

"The world that was e'er I was born,
The world that lasts when I am dead."

In his "Empedocles on Etna," written before he was thirty years of age, Mr. Arnold may be said to have sketched a scientific philosophy of life. We are tempted to quote a verse or two:

"In vain our pent wills fret,
And would the world subdue.
Limits we did not set
Condition all we do;
Born into life we are, and life must be our mold.

"Born into life!—man grows
Forth from his parents' stem,
And blends their bloods, as those
Of theirs are blent in them;
So each new man strikes root into a far foretime.

. . . . . .

"The world's course proves the terms
On which man wins content;
Reason the proof confirms—
We spurn it, and invent
A false course for the world and for ourselves false powers.

. . . . . .

"I say: Fear not! Life still
Leaves human effort scope.
But, since life teems with ill,
Nurse no extravagant hope;
Because thou must not dream, thou need'st not then despair!"

The world has lost in Mr. Arnold a man ever loyal to the cause of truth, and ever interested in the cause of humanity. We may sometimes have been tempted to regard him as an opponent of scientific discipline; but upon a general review of his career we are compelled to recognize him as an ally, not an adversary, and as one who, just because he cultivated a special field of his own by methods of his own, will not easily be replaced. All the more, then, must we value, as elements of progress, the spirit that breathes through his works and the influence bequeathed by his character.

LITERARY NOTICES.

THE RELIGIOUS SENTIMENTS OF THE HUMAN MIND. By DANIEL GREENLEAF THOMPSON, author of "A System of Psychology," "The Problem of Evil," etc. London and New York: Longmans, Green & Co., 1888.

IN the volume before us, Mr. Thompson has entered upon a fruitful field of thought and discussion—one, moreover, which requires great tact and delicacy in its cultivation if the author would secure the sympathetic and respectful attention of his readers. In this respect Mr. Thompson has been notably successful. His treatment of his topic is calm, temperate, philosophical, free from bias, appealing to reason rather than to theological or anti-theological prejudices. While his discussion of the religious problem is entirely frank, manly, and unconventional, it is also duly considerate of those conceptions which he is compelled to discredit and oppose. Some of his conclusions will, nevertheless, probably surprise not only those who are conservative adherents of the Christian faith, but also those who have accepted agnostic or radical views.

Our author defines religion as "the aggregate of those sentiments in the human mind arising in connection with the relations assumed to subsist between the order of Nature (inclusive of the observer) and a postulated supernatural." His use of the term "supernatural" appears somewhat misleading, on account of the character of the antithesis popularly assumed to subsist

between "Nature" and the "supernatural." By the "supernatural" is commonly understood a region beyond the visible universe of law, peopled by arbitrary intelligences which may descend into the natural order, and interrupt its sequence, either for good or for ill. Mr. Thompson's "supernatural," on the contrary, is clearly neither more nor less than the philosophical "unknowable"—the ultimate mystery lying behind phenomena, the only possible knowledge of which is a negative apprehension.

We might question also whether this definition is sufficiently inclusive. How, for example, can Mr. Thompson consistently assign a religious character to positivism, which finds its object of worship wholly within the natural order of the world; or to Dr. Abbot's "scientific theism," which rejects not only the popular notion of the supernatural, but also the Spencerian "unknowable," basing its worship upon the knowledge of an infinitely relational and absolutely knowable universe? Mr. Thompson, indeed, apparently recognizes positivism as "the religion of social immortality," asserting that "the doctrine of deity characteristically belonging to this system of belief is essentially pantheistic." Comteism, however, expressly repudiates all cosmic implications in the object of its worship—its *Grand Être* being simply organic humanity. Even pantheism, as limited to the Cosmos, does not imply supernaturalism. Rather, as in the words of Goethe, it repudiates it:

> "What were the God who sat outside to scan
> The spheres that 'neath his finger circling ran?
> God dwells within, and moves the world and molds,
> Himself and Nature in one form infolds."

Mr. Thompson argues, indeed, with great acuteness and force, that "a postulated supernatural is conditional for all knowledge whatsoever." Those who accept his psychology will doubtless assent to this statement. A primary definition of religion, however, it would appear to us, should be broad enough to cover all philosophical theories.

Parts I and II ("Religion and Religious Sentiments," and "Religious Sentiments in Relation to Knowledge") are devoted chiefly to definition, preliminary explanation, and the development of the psychological basis of the argument. As this has been treated *in extenso* in the author's "System of Psychology," it does not call for special elucidation here. Throughout life, he argues, the *ego* perceives that its activity is necessarily limited. Beyond the limit the consciousness posits a somewhat which is real, yet incomprehensible. Thus arises the idea of the supernatural (unknowable). To the questions why? whence? and whither? which it suggests, we can find no adequate solution. Attempting to make the supernatural the object of thought, we find that we can only do so by ascribing to it the attributes of Nature. Thus, we form symbolical notions of it which vary with changing conditions of mental development. So arise anthropomorphic conceptions of supernatural beings, ideas of heaven and hell, the assumed connection of supernatural intelligences with natural phenomena, etc. This belief in supernatural interference induces fear, impels worship, and influences conduct.

Our author ranks polytheism above monotheism as an incentive to intellectual and social progress. The latter is autocratic and subverts the individual judgment. The former, aristocratic in its nature, stimulates thought and encourages literature and art. Christianity, with its Trinity and angelic hierarchy, he regards as a polytheistic rather than a monotheistic faith. Pantheism is democratic, and favors the free development of the individual reason. Between these different conceptions of the supernatural, truth furnishes no criterion of judgment. We can affirm of neither of them anything more than its probability.

In the chapter on "The Continuity of Personality," Mr. Thompson argues from scientific and psychological analogies in favor of a future life. Admitting that the subject is beset with difficulties, he inclines to the opinion that "the ground for the assertion of *post-mortem* personal self-consciousness in identity with *ante-mortem* self-consciousness is firmer than the contrary belief." A future life implies social relations, and the hypothesis of the separation of the good from the evil, with the final reclamation of the latter, seems reasonable. Our author furnishes no theories of his own concerning the nature or location of the supernatural world. In Part III ("Religious

Sentiments in Relation to Feeling and Conduct") he recognizes the belief in a future life as favoring high ideal ends, while disbelief depresses the mental energies, and fosters selfish enjoyments at the expense of social activities. He condemns theological organizations which condition their fellowship on the acceptance of creeds, and commends the constitution of the Free Religious Association as the best platform for a religious organization. "An æsthetic worship guided by truth" is, he thinks, a benefit to the human race.

The final chapters on "The Education of the Religious Sentiment" have already appeared, in substance, in "The Popular Science Monthly." They present strong arguments for unpartisan scientific instruction in the history of religions, and the complete secularization of our public schools as the fairest and most practicable means of preserving their integrity and usefulness. The book, as a whole, stimulates thought and holds the attention of the reader. In connection with "A System of Psychology" and "The Problem of Evil," it justifies us in ranking its author among our ablest philosophical thinkers.

THE COUNTING-OUT RHYMES OF CHILDREN: THEIR ANTIQUITY, ORIGIN, AND WIDE DISTRIBUTION. A Study in Folk-Lore. By HENRY CARRINGTON BOLTON. London and New York: D. Appleton & Co. 1888. Square 8vo. Pp. xii–123. Price, $2.50.

IN this handsomely-printed volume the author has collected a large number of the curious doggerels used by children in counting-out for the purpose of determining who shall be *it* in certain games. He details the customs as practiced in Great Britain and America, and gives many examples, such as—

> "One-erzoll two-erzoll zick-erzoll zan,
> Bobtail vinegar, tickle 'em tan;
> Harum squarum, virgin marum,
> Zinctum, zanctum, buck!"

The author then shows that children of all civilized and semi-civilized races have similar practices, and repeat doggerels with common characteristics; examples are given in twenty languages, including Japanese, Hawaii, Marâthî, Arabic, Turkish, Bulgarian, Basque, and all the modern languages of Europe. The collection of rhymes numbers nearly nine hundred, of which about four hundred and seventy-five are in English. This wide distribution of the process of counting-out, and the fact that in all languages certain features of the doggerels are common, point to great antiquity for the custom, which, the author claims, originated in the superstitious practice of divination by lot—sortilege. This view is borne out by many analogies between ancient methods of divination and the existing children's games. One chapter treats of conjurations, exorcisms, and charms current in early times; another discusses the question whether these rhymes are derived from Latin prayers, and points out the extraordinary literary fraud perpetrated in 1840 by John Bellender Ker. In another chapter the author shows that, to a certain extent, the changes in English rhymes are influenced by geographical environment. In a few instances the exact date at which a given doggerel was composed can be ascertained by its local coloring. The marked influence of German immigration in America is manifest in even these children's rhymes, many of which are of German origin; for example—

> "Ana, mana, bona, mike,
> Barcelona, bona, strike,
> Care, ware, frow, frack,
> Hallico, ballico, wee, wo, wack!"

This undergoes a great many variations. A brief chapter relates to the Anglo-Cymric Score, and the second part of the work contains eight hundred and seventy-seven rhymes grouped under the various languages. The material for this volume was gathered by correspondence, and orally; the sources of the rhymes are indicated in nearly every instance by the initials of the contributors. A bibliography of the works consulted is one feature of the work, which is the first to appear on the subject of folk-lore since the establishment of the Society of American Folk-Lore. The volume appeals to all who recall the happy hours of their childhood. Several English literary papers have announced this work as written by *Mrs.* Carrington Bolton—an absurd blunder. The author is known by his publications on chemistry and bibliography, and was professor in Trinity College, Hartford, for many years.

DISEASES OF MAN: DATA OF THEIR NOMENCLATURE, CLASSIFICATION, AND GENESIS. By JOHN W. S. GOULEY, M. D. New York: J. H. Vail & Co. Pp. 412.

THE author's purpose in preparing this book has been to urge the official adoption of a stable basis for the nomenclature and classification of disease; to advance some propositions that may contribute to that end; and to call attention to the improprieties evident in the present unsystematic nomenclature, with a view to enforcing the need of reform. The book is, in short, offered as "a plea for the more systematic study of diseases, and as an individual protest against their existing nomenclature and classification, with the hope that this protest will become general among teachers and others, who realize the necessity of bettering the condition of medicine, without undertaking to destroy its fabric in order to reconstruct it; but rather to modify, simplify, and improve it by gradually substituting exact terms for those which have never conveyed correct ideas." While it is easy to attach an exaggerated importance to mere names, it is evident that a philosophical nomenclature, based upon the real and ascertained principles of the science to which it is to be applied, is a great aid to the understanding of that science and to forwarding its advance. But the practical difficulty arises in every science, and every nomenclature, that names have to be found and used before it is possible correctly to determine the principles. In this fact, which is unavoidable, unless we would carry on our science without words, we find the origin of the anomalies in names—the wrong names and the unmeaning names—of which Dr. Gouley complains, and which he makes this effort to correct. He recognizes the nature of the evil, and, while anxious to find a remedy and apply it, does not overlook the importance of acting prudently upon the matter. Therefore he says: "Conservatism is praiseworthy when applied to words that have stood the test of years, and are still adjudged good and proper. Those time-honored terms which convey ideas with precision should be jealously preserved; but that multitude of misleading expressions, to be found in the literature of medicine, should be speedily blotted out of coming medical treatises and dictionaries, and their places filled with well-chosen and philologically correct words." True to the spirit thus exhibited, he does not so much suggest a new set of names, although that point is not overlooked, as he discusses the principles on which the classification of diseases and their nomenclature should be based. With the discussion are embodied reviews of the various systems of classification that have been introduced to the profession by its most eminent representatives of all ages, from Hippocrates down to Broca. The final conclusion is reached that any system of nosography, to be of utility to those whom it concerns, should be the result of the conjoint labors of the medical profession of all the civilized nations.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR 1885–'86. N. H. R. DAWSON, Commissioner. Washington: Bureau of Education. Pp. 21 + 792.

THIS report has been prepared by N. H. R. Dawson, who was appointed commissioner soon after the close of the year which it covers. The new commissioner determined, after the completion of the report for 1884–'85, which was still in hand, to concentrate the work of his force upon the preparation of the present volume, so that this and future reports might appear more promptly than previous issues have. The result has been that, while the preceding volume was distributed twenty-two months after the end of the year which it covers, the report for 1885–'86 has not been so long delayed by three months. This is a commendable change, for many of our Government reports lose much of their value by delay in preparing and publishing them. Mr. Dawson has also revised the plan of the reports, with a view of further facilitating prompt preparation and early printing of the document. The nature of the change is "to avoid repetitions, to omit unimportant items, to consolidate related but hitherto separated facts, and to unite the discussion of statistical conditions with the tabular statements wherein they appear." The appendices contain the usual statistics thus modified in form. Appendix I deals with State school systems. Its statistical tables are followed by a *résumé* of the general condition of public schools in the several States and Terri-

tories, drawn chiefly from the printed reports of the superintendents thereof, and it concludes with an abstract of the public-school laws of each State and Territory. A later appendix contains the report of the General Agent of Education in Alaska for the year 1886–'87. Among the subjects to which the commissioner directs attention are the purpose and condition of secondary instruction, the need to professional students of a previous liberal course of study, and the value of manual training in its influence on the mind.

THE AMERICAN GEOLOGIST. Vol. I, No. 1. January, 1888. Minneapolis. Monthly. Price, $3 a year.

THE geologists of America are to be congratulated that their branch of science now has its special journal in this country. This magazine, it is announced, will be devoted to geology in its widest sense. "It will include, therefore, within the scope of its discussions and contributions all the sciences that are kindred, and that contribute by their more special investigations, to the general science of geology. It will hence serve as a medium of intelligence to the stratigrapher, the petrographer, the paleontologist, the mineralogist, the fossil botanist, the climatologist, the chemist, the physicist, the seismologist, the glacialist, the anthropologist, and the astronomer, in all those directions where their special investigations bear directly upon the constitution and history of the globe." The "Geologist" will also make a special effort to aid the teacher of geology, both by suggesting methods of instruction, and by furnishing new facts and illustrations. It will urge co-operation and organization among geologists, and will aim to preserve and increase that general interest in geological science which supports both private and national investigations. The editors and proprietors are Prof. Samuel Calvin, Prof. Edward W. Claypole, Dr. Persifor Frazer, Prof. L. E. Hicks, E. O. Ulrich, Dr. A. Winchell, and Prof. N. H. Winchell. The first number contains six short articles, an editorial on "Geology in the Educational Struggle for Existence," and another reviewing "Irving and Chamberlin on the Lake Superior Sandstones." There are also departments for book-notices, and for personal and scientific news. It must be confessed that the "Geologist" starts out with a somewhat sectional aspect—only one of its seven editors residing east of Ohio, and only one of the six body articles in this number, that on the International Congress, dealing with anything but Western formations. The latter feature, at least, should be corrected in future numbers.

THE MOVEMENTS OF THE EARTH. By J. NORMAN LOCKYER, F. R. S. London and New York: Macmillan & Co. Pp. 130. Price, paper, 60 cents.

IN this little volume the author has presented a general view of that part of astronomy relating to the planet on which we live. The first chapter deals with methods and instruments for measuring angular space, and is followed by a chapter on the measurement of time. The rotation of the earth, the earth's revolution, and the conditions of its revolution, are successively described, and the closing chapter is devoted to such results of rotation and revolution as the succession of day and night and of the seasons, precession and nutation, etc. The style of the book is clear and popular, though without special effort to be entertaining. The author intends to follow this volume with others, dealing with other celestial bodies.

FOOD-ADULTERATION AND ITS DETECTION. By JESSE P. BATTERSHALL, Ph. D., F. C. S. New York and London: E. and F. N. Spon. Pp. 328. Price, $3.50.

THE public has at least partly awakened to the dangers which the avarice of dishonest dealers in food-products is spreading around it more thickly than ever before, and it is calling upon health-officers, chemists, physicians, and the reputable dealers in these articles for protection. The special scientific knowledge needed by those who stand in this relation to the public is furnished by the present work, which is designed to be a trustworthy guide to the latest and most approved methods of detecting foreign substances in foods and beverages. The articles treated comprise the common infused drinks, dairy products, bread and bread materials, sugar, alcoholic beverages, water, spices, etc., and the tests described are both chemical and microscopical. The volume is illustrated with photomicrographic plates showing the appearance,

under the microscope, of milk, butter, and other fats, starches, spices, and organisms found in water; also with plates representing tea and other leaves and the construction of the polariscope. This work will have a value to American analysts over all previous books on food-adulteration in the respect of being written in this country, and hence giving most attention to the adulterations most practiced here. The latest results attained by our National and State Boards of Health in regard to sophistications of food are also inserted. The appendix comprises a bibliography of the subject, with the full text of the most important laws, and a summary of others, recently enacted in this country for the prevention of food-adulteration. The thoroughness and care with which the subject is presented, together with the valuable character of the illustrations, and the helpful features included in the appendix, make the book well suited for the main dependence of the American food-analyst.

A TREATISE on *The Art of Investing*, by *a New York Broker* (Appleton, 75 cents), is what many people will be glad to have. This little book gives the chances for profit and the risks connected with Government and municipal obligations, railroad and other stocks, mortgages, water-works loans and securities, with hints as to when to buy, and —what many investors never think of— when to sell. There is a chapter on speculating, which furnishes many and strong reasons why the inexperienced should let that form of gambling alone. An appendix contains lists of securities, transcribed from the books of our principal exchanges, showing when each security is payable and the amount issued.

A description of *The Vosburg Tunnel* has been published by *Leo von Rosenberg* (the author, New York, $1), in the form of a handsome, abundantly illustrated pamphlet, of quarto size. This tunnel is located near Tunkhannock, Pa., on one of the lines associated with the Lehigh Valley Railroad. It was completed in June, 1886, and is a trifle less than three fourths of a mile long. The pamphlet describes the surveying work for the tunnel, the method of tunneling and the machinery used, the construction of the arching, and various minor matters. There are also tables of progress in excavation and construction, of brick and cement tests, and of contract prices and wages. The many plans, maps, and views make up a record of experience which will doubtless be of value to all in charge of similar works.

The *History of the Ottawa and Chippewa Indians of Michigan*, by *Andrew J. Blackbird* (the author, Harbor Springs, Mich., $1), is a unique publication. It is written by an educated Indian, whose father was chief of the Ottawas, and comprises, besides a historical sketch of the tribes mentioned, a brief history of the author's life, and a grammar of the Ottawa and Chippewa language. Mr. Blackbird has been a United States interpreter under several Indian agents, and afterward was postmaster at Harbor Springs for eleven years, when, the position having become a desirable one, he was ousted. He is now nearly seventy years old, and in scanty circumstances.

Dr. A. P. Peabody has written a volume of *Harvard Reminiscences* (Ticknor, $1.25), which every one who has been in any way associated with the venerable preacher emeritus, or the university, will welcome. It consists of sketches of the college officers whose names appeared with that of the author in the several annual catalogues in which he was registered as undergraduate, theological student, and tutor. There is also a supplementary chapter describing Harvard College sixty years ago.

Mrs. L. M. Morehead has put together *A Few Incidents in the Life of Prof. James P. Espy* (Clarke & Co.), in order to correct an impression that his early education was neglected, which is given by the statement in Ben: Perley Poore's reminiscences that at the age of seventeen Espy could not read. Had his wife survived him, or had he left any children, we should probably have had a fuller account of the life of the able author of "The Philosophy of Storms."

The Soul, or Rational Psychology of Emanuel Swedenborg, is published by the New Church Board of Publication, New York, in a translation by Mr. Frank Sewall from the Latin edition of Dr. J. F. Immanuel Tafel. It forms the seventh part of the author's great work on "The Animal Kingdom." The position from which Sweden-

borg viewed the world of mind and matter was a peculiar one, and does not correspond with that from which the scientific investigator or even the orthodox Christian of the present day regards it; but all concede, we believe, that he wrote learnedly and honestly, and with thoughts that appeal strongly to certain classes of men. According to the translator, the one desire and aim that animated the entire series of his writings was the "search for the soul." Concerning the scientific bearings of his works, Mr. Sewall declares that they speak "the glorious promise of a reward to be reached higher even than that sought for; of an end whose realization, only blindly striven for in the ascending ladders of knowledge, finally fills and illumines all the subordinate science with a light, a warmth, a beauty inconceivable before. . . . The scientists of the present day, with their careful elaboration of the facts of sensuous knowledge, are building wiser than they know; their own aims, the particular theories they seek to establish, are of minor account—they are the baubles placed before it to induce it to walk"—leading them on, of course, toward the realization of higher discoveries.

Another new language has been constructed, and is described by the inventor, *Elias Molee*, in his *Plea for an Amerikan Language* (the author, Bristol, D. T., $1.25). This language is based on English, rejecting all words not of Germanic origin, and with its spelling made phonetic by the aid of new letters, and its inflections made regular. Vowels have been preferred to consonants for inflectional endings, in order to give the new language more euphony than English has. The author claims that his Amerikan or Germanic-English language has the same excellences as Volapük, and is better adapted for use by the Germanic race.

The *Report of the New York Agricultural Experiment Station for 1887*, *E. L. Sturtevant*, Director, embodies the results of experiments in quite a wide range of subjects. Considerable work on the movements of soil-water and on the cultivation of the potato is reported. This volume contains also descriptions of varieties of twelve important vegetables, with classification, etc., nearly all of the varieties described having been grown at the station more than one season. Many minor topics have also received attention.

Dr. William H. Holcombe's pamphlet entitled *Condensed Thoughts about Christian Science* (Purdy Publishing Company) differs from the common run of expositions of this doctrine in being written in good English, and in showing for its author some ability to think. It presents a fairly clear view of the not very clear theory of "Christian science," or rather the author's interpretation of that theory, for hardly two writers on the subject agree with any closeness.

Fever-Nursing, by *J. C. Wilson* (J. B. Lippincott Company), is one of a series of "Practical Lessons in Nursing," by different authors, published by the same house. It is designed for the use of professional and other nurses, and especially as a textbook for nurses in training. The instructions were first given in courses of lectures given before the nurse class at the Philadelphia Hospital. In them the author has sought to treat the subject in plain words and from the standpoint of the physician, and to teach not only how fever-patients are to be cared for, but why they must be cared for in particular ways.

The *Outlines of Practical Physiology* of Mr. *William Stirling* (P. Blakiston, Son & Co., $2.25) was designed primarily for the use of students in that branch in Owens College, and is now published in the belief that it will be found useful to other students as it has been to them. The peculiar feature of the book, as among students' manuals, is the prominence which is given to actual experimental work. It is, in fact, almost wholly a list and description of experiments, which the reader is expected to perform, according to the directions, for himself. They have been performed by the author in illustration of his lectures, and also by every member of his class. None of them, however, involve the infliction of pain upon living animals.

L'Iodisme (Iodism), by *Elizabeth N. Bradley*, of Dobbs Ferry (G. Steinheil, Paris), embodies in a volume of 168 pages the results of careful studies of the action of iodine upon the system, and the effects it produces

upon the different parts, and under different forms of administration. The author began her experiments for the investigation of the cutaneous eruptions produced by iodine and bromine, but soon found that to form an adequate conception of the etiology of these cases it would be necessary to regard the processes of iodism and bromism in their entity. Then she became convinced that the processes were only a strong accentuation of the symptoms, considered normal of medication, to which little regard had been attached. Thus her investigation gradually became so thorough and far-extending that she was brought to confine it for the present to iodine, leaving bromine to a subsequent research.

Stimulants: Uses, and how best conserved, by *J. M. Emerson* (Dick & Fitzgerald, 50 cents), considers the temperance question from a point of view not usually taken. The author regards alcohol as a natural product, having beneficent uses, and seeks to separate those uses from the abuses of strong liquors and intoxication. While condemning all strong liquors, he holds pure wines to be altogether good, and believes that, with the exception of special cases of uncontrollable inebreism, the use of them tends to limit itself and is entirely safe; and that in their use lies the most effectual method of breaking up the alcoholic habit.

The Invalid's Own Book, by the Honorable Lady *Cust* (Gottsberger, 60 cents), is a collection of brief recipes for preparing a wide variety of dishes and beverages. It includes various teas, waters, milks, gruels, jellies, puddings, soups, breads, sirups, and punches, together with a few kinds of fish and meat.

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Ballard, H. H. Three Kingdoms. New York: Writers' Publishing Company. Pp. 167. 75 cents.

Brooks, Elbridge S. The Story of New York. Boston: D. Lothrop & Co. Pp. 311. $1.50.

Bruce, A. T. Embryology of Insects. Baltimore: Publication Agency of Johns Hopkins University. Pp. 31, with Six Plates.

California. Historical Society of Southern California, Los Angeles. 1887. Pp. 55.

Chisholm, Julian J., M. D., Baltimore. Anæsthetics. Pp. 150.

Clark, J. B., and Giddings, F. H. The Modern Distributive Process. Boston: Ginn & Co. Pp. 77. 75 cents.

Cook, G. H. Report of the State Geologist of New Jersey. 1887. Trenton. Pp. 45, with Maps.

Cossa, Dr. Luigi, and White, Horace. Taxation: G. P. Putnam's Sons. Pp. 213.

Doran, E. W. Report on the Economic Entomology of Tennessee. 1886. Pp. 96.

Dulles, C. W., M. D. Accidents and Emergencies. Philadelphia: Blakiston. Pp. 123. 75 cents.

Field, H. M., and Ingersoll, R. G. "Faith or Agnosticism?" North American Review. Pp. 88.

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POPULAR MISCELLANY.

The Discoverer of Chloroform. — The Jefferson County (N. Y.) Historical Society, having secured the battle-field of Sackett's Harbor, besides erecting a monument to the soldiers buried there, has determined to perpetuate the memory, in a similar way, of Dr. Samuel Guthrie as the discoverer of chloroform. In aid of this object, Mr. O. Guthrie has prepared an account of Dr. Guthrie and his work, in which his claims to the original discovery of chloroform are set forth. Dr. Guthrie was born the son of a practicing physician in Brimfield, Mass., in 1782. He was an examining surgeon in the army during the War of 1812, and established a vinegar-factory at Sackett's Harbor, for supplying the military post there. In 1817 he removed to that place, and prosecuted experiments in the manufacture of powder, which, extending over a period of nearly forty years, were, perhaps, more extensive than those of any other man of his day. The priming-powder—"percussion pill"—made there, is of his invention. He died in 1848. His claim to priority in the discovery of chloroform rests upon his publication, in "Silliman's Journal" for October, 1831, of an article which circumstances indicate to have been written not later than in July of the same year, describing the preparation and properties of a spirituous solution of chloric ether. The ether was prepared by distilling chloride of lime with alcohol. In the article referred to, Dr. Guthrie says: "During the last six months a great number of persons have drunk of the solution of chloric ether in my laboratory, not only very freely, but frequently to the point of intoxication; and, so far as I have observed, it has appeared to be singularly grateful, both to the palate and stomach, producing promptly a lively flow of animal spirits and consequent loquacity, and leaving, after its operation, little of that depression consequent to the use of ardent spirits. This free use of the article has been permitted, in order to ascertain the effect of it in full doses on the healthy subject; and thus to discover, as far as such trials would do, its probable value as a medicine." The subject has been investigated since the publication of Mr. Guthrie's pamphlet, by a committee of the Chicago Medical Society, whose report, we understand, fully substantiates Dr. Guthrie's claim to priority. It appears, in fact, that the account of Dr. Guthrie's process for obtaining chloric ether was in the publisher's hands prior to May 8, 1831; that his chloroform was at the same time in Prof. Silliman's hands for distribution; and that experiments had then been making with the article for six months. This would carry the date of the discovery back into 1830. The claim of Dr. Soubeiran, the Frenchman, is based upon the publication of his account in January, 1832; and Liebig's work upon the subject was, by his own assertion, completed in November, 1831.

Training for Census-Work.—Hon. Carroll D. Wright, Commissioner of the United States Bureau of Labor, in a recently published paper on "The Study of Statistics in American Colleges," says: "I would urge upon the Government of the United States, and upon the governments of the various

States, the necessity of providing by law for the admission of students that have taken scientific courses in statistics as honorary *attachés* of or clerks to be employed in the practical work of statistical offices. This can be very easily done without expenditure by the Government and with the very best economic results. We take a census of the United States every ten years, but, as a rule, the men that are brought into the work know nothing of statistics. They should be trained in the very elementary work of the census-taking and of statistical science. How much more economical for the Government to keep its experienced statisticians busily employed in the interim of census-taking, even if they do no more than study forms, methods, and analyses connected with the presentation of the facts of the preceding census! Money would be saved, results would be more thoroughly appreciated, and problems would be solved."

Plant-Lice and their Insect Enemies.—Two features in the life of plant-lice are the enormous rate at which they multiply, and the suddenness with which they sometimes disappear. The cherry-trees may be black with them in May, and in a month hardly a specimen of them will be found. This welcome riddance is due to their insect enemies. A syphus maggot with a pointed head, says Mr. A. J. Cook, of the Agricultural College, Michigan, just revels in plant-lice. It seems never satiated, and it is hard to understand how so small an insect can make so large a meal. The lady-birds, and especially their larvæ or grubs, do signal service in the same direction. Several species of the genus *Aphidius* of the ichneumon family, very minute parasites, destroy the lice by the thousands. Thus, plant-lice on out-door vegetation, which may threaten dire mischief early in the spring, are almost vanquished before summer comes. In some years, however, probably favored by drought, the plant-lice live out of proportion, and succeed in spite of their enemies, when they do most serious injury. They are sometimes favored, too, by misguided cultivators, who destroy their enemies, mistaking them for mischievous insects. The aphides may be destroyed by the kerosene-and-soap mixture, which consists of a quarter of a pound of hard soap or a quart of soft soap, and a quart of water, heated till the soap is dissolved, to which a pint of kerosene is added, and the whole agitated till a permanent emulsion or mixture is formed. It is applied with a force-pump, of which some are made for the purpose.

Monuments, Sculptures, and Inscriptions at Copan.—Mr. A. P. Maudsley has made a systematic examination of the principal ruins of the ancient city of Copan, in Central America, one of the most interesting of the sites explored and described by Stephens in his first account of his investigations. Mr. Maudsley's examination included surveys and measurements of the mounds, excavations, and the taking of casts, which will be preserved in the South Kensington Museum. He believes that the nature of the structures has been in some points mistaken; that the so-called pyramids are the raised foundations which supported roofed buildings—probably temples—which were approached by steep flights of steps; that the long heaps of stones which were taken to be the ruins of city walls are in fact the remains of single-chambered, stone-roofed houses; and that the great "river-wall" is merely a wall in appearance, resulting from the river having changed its course and eaten into the raised terraces and lofty foundations on the east side of the ruins, the plan of the structure on that side having been originally the same as on the other sides, with slopes and stairways. A few worked stones, including some beads and a whorl of jade, pearls, and carved pieces of shell, a pot containing red powder and several ounces of quicksilver, human bones, dog's teeth, and skeletons of jaguars, parts of one of which were painted red, were found in the excavations. Mr. Maudsley adduces evidence, from the failure of all the Spanish chroniclers to make any mention of the cities which these ruins represent, or of anything like them, and from the comparison of the ruins with what the Spaniards did speak of, that the sites had been deserted, and the buildings buried in the forest and lost, long before the time of the conquest. The ruins of Copan have been famous ever since Stephens made them known, for the profusion of sculptured orna-

ment and hieroglyphics which they bear. In examining them, Mr. Maudsley was struck with the frequency with which the serpent symbol, usually the plumed serpent, is used in the sculptures. It appears in the scroll-work, is often found in connection with a natural or more or less grotesque human head; and occurs under various disguises, in many of which its presence is not revealed at first sight. One of the most interesting points noticed in the inscriptions—which the author believes should be read in double columns, from left to right, and from top to bottom—is that all those which there is reason to believe are complete from the beginning are headed by what might be called an initial scroll, and begin with the same formula, usually extending through six squares of hieroglyphic writing. The sixth square, or sometimes the latter half of the sixth square, is a human face, usually in profile, inclosed in a frame or cartouche, like the names of the kings in Egyptian inscriptions.

Some Old Natural History and Fables.—The "*Speculum Mundi;* or, a Glass representing the Face of the World," which was published in 1670, before the advent of real science, contains some very curious statements in natural history. The bigness of the whales, it says, "equalizeth the Hills and mighty Mountains." Indeed, some authors mention "far greater whales than these." Above all others, mermen and mermaids are considered "the most strange fish in the waters." A fine specimen of mermaid, which was said to have been caught in Holland, "suffered herself to be cloathed, fed with bread, milk, and other meats, and would often strive to steal again into the sea, but, being carefully watched, she could not. Moreover, she learned to spin and perform other petty offices of women; but at the first they cleansed her of the sea-moss which did stick about her." The ostrich is said to be compounded, as it were, of a bird and a beast. For making a drunkard loathe his liquor, a prescription is given for breaking owl's eggs and putting them into it. Birds-of-paradise "have no wings, neither do they fly, but are borne up into the air by the subtility of their plumes, and lightness of their body." The unicorn is described as being like a two-year-old colt, with a horn growing out of his forehead, "a very rich one . . . being a horn of such virtue as is in no beast's horn besides, which, whilst some have gone about to deny, they have secretly blinded the eyes of the world from their full view of the greatness of God's great works." The gorgon is "a fearful and terrible beast to look upon. He causeth his mane to stand upright, and, gaping wide, he sendeth forth a horrible and filthy breath, which infecteth and poysoneth the air." The cockatrice or basilisk is called the king of serpents, not only on account of his size, but also "for his stately pace and magnanimous mind." His poison scorches the grass as if it were burned. The "beams" of his eyes will kill a man. The dragon is found chiefly in India and Ethiopia. "His wings will carry him to seek his prey when and where occasion serveth"; his teeth are very sharp and set like a saw, but his prodigious strength "resteth in his tail." The amphisbena has two heads and no tail, "having a head at both ends." Africa "aboundeth" with them.

Volcanic Lava-Cones.—Professor Dana observes, in connection with studies of the recent eruption of Kilauea, that in external dress the crater of highly viscid lava is very unlike that of the feebly viscid. The cone in the former often rises with slopes of from 30° to 35°; that in the latter often of but from 5° to 10°. The former commonly uses cinders largely in making its cone, or else has the less fusible orthoclase lavas to deal with; the latter is lava-made, cinder deposits being subordinate to those of lava. The crater in one is lengthened upward at the top by cinders, and has crater-cones about each vent of liquid lava within the crater; that in the other is often a broad pit, with a floor of cooled lava, over which are large and small lava-vents, and low, lava-made cones. The volcano of the former kind is more liable to catastrophic eruption, with noisy earth-shocks, though often quiet in some discharges; those of the latter commonly work with comparative quiet, having their large outflows at times without announcements of any kind to those dwelling a few miles away. There are differ-

ences, but they are differences in some of the results of the action going on, not in causes or methods. The first of the two kinds of volcanoes prepares for a new eruption by the gradual filling up of the emptied crater, doing this by means of one or more lava-vents in the bottom, which, besides throwing up cinders, have their little outflows (as well described by Secchi for Vesuvius), and keep at the work until the crater is filled, or nearly so; and then come the break and the greater outflows. The second kind differ only as to the cinders; and in Kilauea, as to the height of the floor before the outbreak. Both from Vesuvius and Kilauea we learn that, next to the lava-vent, the crater of a volcanic mountain is its prime or most fundamental element. It incloses the extremity of a lava-conduit of greater or less breadth that reaches down to the seat of fires; and this inclosure exists because of the ejections by outflows and upthrows of the consequent down-plunges, which superficial conditions in large part determine. The growing mountain-cone can not be rid of its crater except by the gradual disappearance and healing over of the lava-vent; and, commonly, when extinction happens, the crater is still of nearly full size. If half or wholly obliterated, it may be again restored; and is likely to be, if activity is ever renewed in the region by new aggressive action below. If so renewed, it may go forward through refusions and new ingulfment. But the first step may be the opening of the old fissure upon which the crater was originally made; in this way the lava-conduit might secure for itself at once an open way to the surface. It may be that the course of the old fissure has been a chief cause in determining the form of a crater; and it may lead, in after-history, to changes in the locus of the chief vent, or an elongation of the crater in one direction rather than in another.

Water-Pipes of Lead, Tin, and Iron.—On the question of the "Action of Drinking-Water on Lead," Dr. Tidy, Mr. Crookes, and Dr. Odling have reported to the British Association that they deem it impracticable, even though it were advisable, which they doubt, to replace lead pipes by iron pipes, or even by pipes of tinned lead. In tinned-lead pipes the tinning is found not only to be detrimental to the strength of the lead, but to be likely, unless the coating is perfect, to assist the dissolution of the lead. Iron pipes, although strong, and safe so far as health is concerned, are more likely to break, more difficult to adjust and repair, very easy of oxidation, and liable to obstruction from accumulation of the oxide. Tin is also acted upon by water, though its toxic action is below that of lead. It is fairly flexible, but four times as expensive as lead, but a thinner pipe would suffice. There is reason, however, to believe that waters do not afford a protective coating to tin as they do to lead. The advantages of lead service-pipes are their cheapness, durability, and flexibility, and the ease with which they can be wrought and repaired. The authors recommend the systematic and continuous filtration of the water, with such modifications of the filter-bed as will insure its efficient silication. This will, in their belief, minimize and practically prevent the action of the water on the lead surfaces. It would, moreover, improve the brightness and color of the water, and lessen the quantity of organic matter held in solution.

Practical Chemistry in Housekeeping.—The "Popular Science News" notices some facts connected with the preparation of food that illustrate how the housekeeper is in reality a practical chemist. The object of all cooking, or application of heat to the raw material of food, is to bring about changes in the character of certain bodies of complicated organization; and this is often done without producing any difference in composition perceptible to the chemist. Such is the case when albumen is coagulated: we clear coffee with albumen or the white of an egg, through its power of inclosing particles in suspension when it becomes hard. If the coffee-maker uses fish-skin, it performs the same office by forming a kind of leather with the tannin of the coffee. Glue is a coarse, and cooking gelatin a refined form of the same substance, which is insoluble in cold water, but absorbs it, swelling up and becoming soft. When heated with the water, gelatin dissolves, and then, when cooled again, "jells"; but, if boiled too long, it loses the "jell-

ing" quality; the same property of gelatinizing is possessed in fruits by pectine, which is, however, a distinct substance. The stimulating properties of tea and coffee are due to their peculiar alkaloids, theine and caffeine; their flavor, to aromatic substances which are extracted by the hot water from the leaf or berry. Wheat-flour is composed of starch with gluten, and more or less of mineral or inorganic substances. The finer and whiter flours are nearly pure starch, and are not so nutritious as the less attractive brown flours. The raising of dough is a true process of fermentation, precisely similar to that of the brewer or distiller, but the alcohol soon passes away. Sugar, when heated, melts, and is converted into an uncrystallized, pliant mass, known as barley-sugar, or sugar-candy. At a somewhat higher temperature it is decomposed, and a dark-brown substance, known as caramel, is formed. Granulated sugar is seldom adulterated. The term salt, in its technical sense, includes the fats, which are compounds of characteristic acids with glycerin as a base. Upon adding potash or soda, the acid combines with the alkali, forming soap, and the glycerin is set free. If soda is used, hard soap, if potash, soft soap, is formed.

Purification of Sewage by Infiltration.—Filtration of sewage is defined in the report of the Royal Commission on Metropolitan Sewage Discharge to be its concentration, at short intervals, on an area of specially chosen porous ground, as small as will absorb and cleanse it; not excluding vegetation-culture, but making the produce of secondary importance. On a suitable soil, such as a sandy loam with a small proportion of gritty gravel, specially prepared by surface leveling and deep under-drainage, one acre is said to be capable of purifying the sewage of one thousand people, manufacturers' refuse and storm and surface waters excluded. Mr. Bailey Denton, who has had ten years' experience in filtration, and has published a book about it, does not think it necessary, or even, in most cases, desirable, to precipitate the sludge before applying the sewage to the filtration-beds. He does not believe that under proper treatment sludge is capable of clogging the pores of the land or of injuring vegetation. He advises the laying out of the filtration-beds in ridges and furrows, the sewage only to flow into the furrows and not to be allowed to flood the ridges on which plants and vegetables are growing. As soon as the deposit of sludge on the sides of the furrows is sufficient to prevent infiltration in any great degree, the sewage should be withheld from the areas so affected. The sludge should then be allowed to dry partially in the furrows, and when in a fit condition be lifted and dug into the ridges. The slimy matter, which has appeared so considerable and which puddled the bottom of the furrows when wet, shrinks to a skin of very insignificant thickness when dry, and is readily broken up and mixed with the soil. The intermittency of the application of the sewage to the filter-beds is essential. Each bed should have eighteen hours' rest out of the twenty-four, to allow air to follow the pores of the land, and thereby renew the oxidizing properties of the soil. The assimilative power of growing plants is doubtless also a great aid in the purification of sewage. Intermittent filtration is probably, however, likely to have its most useful application in combination with surface or broad irrigation.

The Slavic Feast of St. Nicholas.—The feast of St. Nicholas takes the place, among some of the Slavic peoples, of our Christmas. The chief feature of the festival is the catechization of the children on the eve of the day, for which the good bishop is personated by a youth dressed in long white vestments, with a silk scarf, and furnished with miter and crosier. He is accompanied by two angels, also suitably dressed, and followed by a troop of devils, having blackened visages, horns, pigs' faces, and other ingeniously devised distortions, and all rattling chains. The visitations take place at the houses where the children are gathered in their evening parties. St. Nicholas enters with two angels, while the devils are left outside. He calls up the children one by one, and seriously examines them, with questions suited to their ages, and in their knowledge of prayers and hymns. Those who pass the questioning successfully are rewarded with presents of nuts and apples; those who fail have to stand aside. After

the examinations are completed, the devils are called in, and, while they are not allowed to annoy the good children, they are permitted to tease the naughty ones as much as they like. The performance passes at last into an hour of jollity and romping. The children having returned to their own homes, and said their prayers previously to going to bed, place dishes or baskets upon the window-sills, with their names written within them, for the presents which St. Nicholas is to bring.

Mithraism.—The religion of Mithra, or, rather, ideas and forms connected with it, played an important part in the thought of the early centuries of the Christian era, yet little is known of Mithraism at the present time, and the discussions of it are largely speculative. It has been generally treated as having been a mere form of sun-worship; but that accomplished antiquary, Mr. J. A. Farrer, has expressed the belief that it was at bottom the worship of Ormuzd, the Persian conception of the Deity, which answers exactly to the Jewish conception of Jehovah. While we may never know what its actual rites or mysteries were, it is evident that they enforced a high and severe standard of morality through a symbolism which now seems ridiculous. Candidates for initiation went through some twelve or, perhaps, eighty trials of physical endurance, by fire, water, fasting, etc., in order to present themselves holy and free from passion. They passed through several degrees, and were called, according to their sex or advancement, lions, hyenas, ravens, eagles, and hawks. There were ceremonies of baptism and absolution, an oblation of bread and water, and a teaching of the resurrection. Symbolical representations were made of the passage of emancipated souls through the fixed stars. But little more is known of the service. The interesting point in the Mithraic rites is their resemblance, as attested by the Christian fathers, to the early Christian rites. This fact suggests a question which controversialists have not neglected — whether the Christians borrowed from the Mithraists or the Mithraists from the Christians, or whether the coincidences are casual. The mysteries of Mithra have also their analogues in the mysteries of ancient India; and it may be that the Christians yielded to the temptation to compromise in order to make the passage of conversion easier; as it is tolerably clear that they did in the appointment of a number of the church festivals. While these resemblances and relations must make this religion a matter of perpetual interest, its origin and nature are in fact "little less obscure than the caverns in which its mysterious rites were once performed. . . . That it was monotheistic in doctrine, and taught the belief in a future life; that it inculcated a code of morality, in which truth, justice, and temperance formed the principal virtues, is all that at present seems clear from the scanty evidence that remains of it."

The Sensations of freezing to Death.—The question, Is death from intense cold painless? is answered by a writer in "Chambers's Journal" from his own experience one day in the Pennine Alps. After a hot July climb to the snow-line, in which the traveler went out of his way in frequent excursions for beautiful objects, and did not eat, the sunset and the rapid change to intense cold took place. Poorly prepared to endure the transition, the writer felt a peculiar appearance in all his surroundings. "Everything looked hazy to my vision—even the snow and the rocks lying about looked as if enveloped in a fog, although the afternoon was beautifully clear. Then I felt that I must sit down and enjoy it; but the guide's flask of *Kirschwasser* set me going again. Very soon, however, the former feeling returned; but the same treatment temporarily recovered me. At last I took to stumbling along, fell down several times, and at length could not help myself. My companions urged me in vain to arouse to one more effort; but it was useless." Two monks from the hospice were brought to the rescue, and they and the guide "took me in hand, and, shaking me up, made my hands clasp a belt round the guide's waist, and each of the monks took an arm," and thus pulled him through the seven and a half miles to the hospice. "The sensations of that journey, during occasional gleams of consciousness," the writer continues, "will never be erased from my mind. Is there such an essence of ecstatic delight as *elixir*

mortis? If there is, it must have been something like it, or the very thing itself, which I enjoyed that day. No words can possibly express the surprising desire which I felt to sit down and enjoy my felicity—and sleep. But my inexorable friends knew that sleep meant death; and though my repeated appeals of 'Doucement, doucement!' were plaintive enough, they were met by redoubled efforts to force me onward, even when my own legs would not move any longer. . . . During the sustained efforts of the three men, I had but momentary glimpses of consciousness. I remember seeing two somethings, black, one on each side, but very indistinct. These, of course, were the friendly monks. The one overwhelming idea that filled my mind then was how to get to that sleep, that blissful euthanasia which poets have sung about, but which my companions were doing their best to rob me of, just when I had got it within my grasp." Hence it is concluded that death from intense cold may at all events be painless.

Half a Century of Railway Work.—Mr. Edward Woods, President of the English Institution of Civil Engineers, entered the service of the Liverpool and Manchester Railway Company more than fifty years ago. At that time the so-called "fish-bellied" rails were used, weighing thirty-five pounds to the yard, and were laid in iron chairs supported on stone blocks. Such beds proved too rigid, and were laid with heavier rails. Then wooden sleepers, being more elastic, were adopted instead of stone, and a wooden wedge, instead of an iron one, for holding the rail in the chair. The steel sleepers now coming into vogue in place of wood are so formed as to give great elasticity, and avoid the blunder of a rigid road. The essential characteristics of the locomotives, though great improvements have been made in them, have not been changed; but a wonderful economy has been effected in the consumption of coal. A larger traffic is now performed with three thousand one hundred tons of coke per annum than was then carried on with twelve thousand six hundred tons. The traction power of engines has increased fivefold, and inclines which were at one time considered too severe to be worked by locomotives are now easily surmounted. The average of speed has been increased considerably, but the maximum not greatly. In all the accessory details of railway work, such as signaling, switching, braking, etc., there has been a great and important advance.

Forestry in Switzerland.—While by the Constitution of 1874 the confederation has the right of supervision, each canton of Switzerland possesses in effect its own scheme of forestry organization. Two systems are prevalent, each of which has its advantages in certain circumstances. In the central, southern, and eastern parts of the federation, the territory of the cantons is portioned into districts of from 17,500 to 30,000 acres each, with an inspector and a number of trained foresters and keepers chosen by the owners of the woods, and paid by them. Each forester has about 3,000 acres under his care, and, under the control of the inspector, carries out the processes of cultivation, looks after the nurseries, clears rides, and disposes of the timber cut down. In the western and less rugged parts of the country, where the cantons have long possessed forest organizations, merely protective measures are subordinated to maintenance of a scientifically trained official staff. Most of the cantonal governments own forests which serve at once as models for the other forest proprietors and as an encouragement for the establishment of private staffs of keepers. In these cantons the superior forester does much that is left elsewhere to unskilled hands. The superior foresters are everywhere nominated and paid by the state, while the under-foresters are mostly selected and paid by the forest-owners. In most cantons forest administration is conducted by a department under the rule of a member of the government, assisted by a chief forester. The pay in all grades of the service is small.

Bean-Curd.—Tofu is a curd manufactured in Japan from beans, and, according to the "Journal of the Society of Arts," "approaches more nearly in its composition to animal food than any other vegetable known." It contains about one fifth of its

weight of fat, and nearly two fifths of nitrogenous matter. This would give it about double the nutrient value of beef. The Japanese prepare it by soaking the beans in water for twenty-four hours, then grinding them in a stone mill with the purest water obtainable, so as to form a thin pulp. The pulp is heated to boiling, when more water is added, and it is boiled again; then more cold water is added, and it is allowed to stand. The liquor is then strained out through a bag, and brine is stirred into it. This effects a coagulation, and the curd is pressed as in making cheese. Prof. W. Matticu Williams has obtained soluble casein by treating peas in a similar manner; and he remarks that all peas and beans will yield soluble casein when so treated. Prof. Williams estimates the cost of producing the bean-curd, equal if not superior to the best cheese made in the dairy, at about threepence per pound.

Whaling in Spitzbergen Waters.—Whaling has been carried on in the Spitzbergen seas during the last forty years, according to Captain Gray, of the steamer Eclipse, of Peterhead, by the aid of the traffic in seals, with whose products the gaps in the cargo of whale-products were filled; but since the introduction of steam-vessels, in about 1860, the seals have been so completely exterminated that it no longer pays a vessel to go in search of them. Steam has also been to a great extent the ruin of the Greenland whale-fishing. The whales are receding farther and farther into the ice, where it is impossible to follow them. So far as can be judged, there are probably no fewer whales now than there were forty years ago, but they are more inaccessible, as they are being yearly frightened farther back by the noise of the steam-engines. Notwithstanding the greater difficulty in penetrating the ice at such a time, a "close season" is welcome to the whale-fisher, for the whale will only appear in the neighborhood of field-ice, and in open seasons the ice is constantly broken up by the swell. In some seasons the whales are later in appearing than in others; but the usual time is about the 20th of May, and from that time the fishing is prosecuted till about the end of June, when the whales disappear. A new branch of enterprise has been developed within a few years in fishing for the small "bottle-nose" whale. These whales yield no bone, but give about a ton each of an oil equal in lubricating power to the southern sperm-whale oil. Since they began to be hunted, more than two hundred have sometimes been killed in a season by a single ship; but there are signs that the trade is being overdone. The oils, formerly the main-stay of the fisheries, were at one time largely used for lighting collieries and street-lamps; but for a good many years back they have been principally employed by jute manufacturers for lubricating purposes. Since the discovery of the great Russian petroleum-wells at Baku, however, the demand for the seal and whale oils has greatly fallen off; but whalebone is now at a higher price than ever. Captain Gray regards the prospect of finding a new and lucrative whale-fishery in the antarctic seas as very hopeful.

Railways as Fosterers of Trade.—The history of railway construction in India illustrates in a remarkable way how rapidly traffic is developed as soon as facilities are opened for it. Until within a year or two past the Government of the country considered that it was unlikely that any railway in India would pay that did not pass through a dense population. The Government was averse to constructing railways in Burmah till business interest urged it so strongly that the experiment was tried, when, to the surprise of the administration, the Burmah Railway paid about five per cent as soon as it was opened. In the same way the Government denied the possibility of extensive traffic upon the Rajpootana and the Indus Valley railways, which were constructed solely for strategic purposes through a poorly populated country, and a narrow gauge was all that it would afford. Yet so rapidly has the country been brought under cultivation, and the population has increased so fast, that in 1885 the Indus Valley Railway carried one hundred and thirty-six million mile-passengers and two hundred and ninety-three million mile-tons of goods and grain, and paid 7·32 per cent on its capital; and the Rajpootana line carried three hundred and fifty-eight million mile-

passengers and three hundred and twenty-seven million mile-tons of goods and grain, and paid 6·97 per cent upon its capital.

Six Hundred Shots a Minute.—The Maxim machine-gun has a capacity for firing six hundred rounds a minute, or at least three times greater than that of any other machine-gun. It has only a single barrel, which, when the shot is fired, recoils a distance of three quarters of an inch on the other parts of the gun. This recoil sets moving the machinery which automatically keeps up a continuous firing at the extraordinary rate of ten rounds a second. Each recoil of the barrel has therefore to perform the necessary functions of extracting and ejecting the empty cartridge, of bringing up the next full one and placing it in its proper position in the barrel, of cocking the hammer, and pulling the trigger. The barrel is cooled with a water-jacket, is adjustable in every direction, and has a maximum range of eighteen hundred yards. The gun weighs only one hundred and six pounds; it can be taken apart, folded up, and put together again, the latter operation being possible in ten seconds.

NOTES.

How timber can be intelligently cultivated on farm-lots of from sixteen to twenty acres was explained by Mr. Benjamin Hathaway at the Michigan Forestry Convention. While the timber is young the ground can be used for pasture, and even for wheat and oats. After the shade has grown dense, the temporary value of the land is reduced; but in eight or ten years afterward the timber becomes marketable. Trees planted in border screens, ten feet apart, will support a wire fence, afford a supply of fire-wood from their trimmings, and add positively to the attractiveness, value, and profitable cultivation of the farm.

The French Association met this year in March, at Oran, in Algeria. M. Laussedat was chosen president, and delivered an address on the civilizing influence of science. The meeting was held in the spring instead of the summer, on account of climatical considerations. One previous meeting of the Association—that of 1881—was held in Algeria.

The great Bressa prize of 12,000 francs, or $2,400, has been awarded to M. Pasteur by the Academy of Sciences at Turin.

Mr. Vincent Jackson, senior surgeon of the Wolverhampton and Staffordshire General Hospital, who is also Mayor of Wolverhampton, presided recently at a "Burial Reform" meeting, and defined the reforms required to be: coffins of the most perishable and lightest material, all lasting substances being rejected; interments as early as possible; the pall to be discarded as an unnecessary and baneful covering, and burial in plain earth with total disuse of vaults and bricked graves. Vaults were condemned by Dr. Malet, medical health-officer for the borough, as tending to the spread of disease, and injury to the health of persons attending burials.

A collection of objects relating to religion—altars, priests' robes, and kindred objects—made in the course of several years by M. Guimet, was some time ago presented by him to the municipality of Paris on condition that a building should be specially devoted to them. The building, which is close to the Trocadéro Palace, has just been finished, and will shortly be occupied as a museum of religions.

"Railway-brain" is a term applied by Dr. Thomsen to a neurosis or general derangement of the nerves produced by a shock received by the head on a railway-car. In the particular case described, no wound was received, and consciousness was preserved at the time of the injury. Afterward the patient became melancholic, and complained of insomnia, headache, spinal pain, weariness, and failure of appetite. A hygienic and palliative treatment was given.

An interesting experiment was recently made by a Dr. Durand, in reference to the relative power of imagination in the two sexes. He gave to one hundred of his hospital patients a dose of sweetened water, and shortly afterward entered the room, apparently greatly agitated, saying he had by mistake administered a powerful emetic. In a few minutes four fifths of the subjects were affected by the supposed emetic, and were mainly men, while every one of those not affected were women.

M. Bonnetoud, a French engineer, employs the explosive force of dynamite to drive out, for a brief period, the water from portions of wet ground in which foundations are to be made. A hole is bored in the wet ground, ten or twelve feet deep, and about an inch and a half wide. By exploding cartridges of dynamite in this hole the water is driven far out beyond the sides of the yard-wide cavity which is produced, and does not reappear till after half an hour at least. The workmen thus have time to clear the cavity and introduce quickly-setting concrete.

THE deleterious effect of arsenic upon the skin was recently discussed in the Pathological Society of London, after a communication by Mr. Jonathan Hutchinson. The skin is the tissue on which arsenic has perhaps its most marked influence. The poison may spoil the complexion instead of improving it, by making it muddy and unsightly. A similar action is exhibited in all parts of the skin, and may lead to the development of soft corns, not warts, in the palms of the hand and soles of the feet, where a roughened condition also grows up under its influence. Mr. Hutchinson expressed the belief that arsenic can produce epithelial cancer.

ASSUMING that the coincidence of the earth's perihelion passage with the summer solstice every twenty-one thousand years marks the regular recurrence of a northern glacial period, M. Adolphe d'Assier has calculated that the last glacial period reached its culmination in 9250 B. C., and that the alternating period of greatest warmth in the northern hemisphere occurred A. D. 1250, after which we immediately began to move toward the next glacial period, which will reach its height in, say, A. D. 11,750. Hence the north must have been growing cooler during the last six hundred years. Evidence is not wanting, M. d'Assier asserts, in changes that have been observed in the northern limits of growth and ripening of certain plants, that this has been the case, and he names several instances.

DR. R. W. SHUFELDT, in a paper on Dr. Thomas H. Street's collection of birds' sterna and skulls, mentions as a fact long well known to him, which is illustrated by specimens in the collection, that there are a great many species of North American birds that gradually increase in size as we pass from the southern parts of the country toward the north.

THE Congo in the neighborhood of Stanley Falls, according to the account of an English engineer formerly in the service of the Free State, is so full of islands that an uninterrupted view from bank to bank is obtained at only three or four points. The misleading statement, without mention of the islands, that both shores are seldom visible at the same time, has given rise to mistaken and exaggerated ideas of the size of the river. The great plain, some five hundred miles in extent, through which it runs here, is covered for the most part with dense tropical jungle, abounding in rare and valuable forms of plant-life. Tree-ferns, and many varieties of orchids yet undescribed, are common, as well as the wild coffee shrub, several kinds of plants yielding India-rubber, mahogany, and other splendid timber-trees.

A CURIOUS combat between two hawks and an owl is described in Major-General Newhall's "Highlands of India." The three birds first performed a preliminary series of upward gyrations, each endeavoring to get a position of advantage above the other. Finally one of the hawks made good his stroke, and both birds fell to the ground like a stone. When the author rode up, the little hawk was standing in the attitude of a conqueror on the owl's body, whose head he had twisted off and held in his claw.

THE world consumes annually, according to an English authority in the trade, about 650,000 tons of coffee, and produces a corresponding quantity. Estimating the average price at $400 a ton, this represents a value of $260,000,000. Jamaica coffee is the finest grown, but only furnishes about 5,000 tons. East Indian and Ceylon coffees are of very high quality, but they do not together produce more than 25,000 tons. The Ceylon crop used to be more important than it is, but has been reduced in consequence of a disease of the plants. The average crop of Java is from 60,000 to 90,000 tons, and that of Brazil from 340,000 to 380,000 tons. Costa Rica and the other Central American states also export coffee.

WHILE it appears from the records of English health officers that some diseases have special seasons in which they are most likely to prevail, it is not shown that occasional variations in temperature have much influence in the matter. Scarlet fever is at its minimum from January to May, and at its maximum in October and November. Diphtheria is more evenly distributed through the year, and is most dangerous a little later than scarlet fever. Measles and whooping-cough seem to be somewhat aggravated by cold weather, but are most fatal in May and June. Hot weather is adverse to small-pox, and favorable to disorders of the bowels, particularly in children.

RUNNING to catch trains is declared to be dangerous, not only on account of the immediate perils it involves, but also because it tends in the long run to shorten life. We—at least persons who have passed middle age—have only a certain amount of reserve force, and all that we draw upon in hurries is abstracted from that which should be distributed through the remainder of life. The secret of longevity is probably skill in so economizing the reserve of vital energy as to make it last out an unusual period. Persons who begin unusual exercises in youth may adapt their constitutions to the habit, and may thereby hold on to their full term of life; but this can not be done safely if one waits till mature age before beginning.

DEW is known to play an important part in the growth of plants by furnishing them and the surface of the soil with moisture. In hot and rainless countries and seasons, in fact, plants would not be able to reach maturity were it not for the dew which supplies the deficiency of rain. According to M. Prillieux, dew plays another and mischievous part in promoting the growth of parasitic fungoids, whose spores, brought by the wind, owe to it their power to germinate on the plants on which they light.

A COMMITTEE of the English Medical Council has been appointed to consider the best means of increasing the practical element in medical education. Although the strictly scientific parts of medicine are taught as they never have been taught before, it is conceded that there has been a falling off in the practical part, and that the new graduate, although more learned in minute anatomy, chemistry, and physiology than his predecessors, is less apt at recognizing and treating common diseases.

THE capacity of magnesia to form a cement, long known, has been regarded from a practical point of view since the residues and sub-products of the Stassfurt potash manufacture have risen to commercial importance. Dr. Frank's cement of magnesia and chloride of magnesium was unfortunately liable to the objection of swelling and breaking up, like some of the lime-cements, in consequence of slow hydration. Dr. Grundman, of Hirschberg, has patented a new process, in which, instead of calcining the magnesia and treating it with water, he makes a carbonate of it by exposing it to carbonic acid as produced by the burning of coke in close apartments. It thus forms a substance as hard as magnesite and capable of taking on a fine polish. Mixed with marble-dust, it forms an artificial dolomite; and, with soluble silicates, an artificial stucco.

EXPERIMENTS with an electric locomotive are now being made on one of the underground roads in London, which, if successful, will do away with the chief annoyance of underground travel, the smoke, and the danger incident to carrying a powerful electric current along the line will be very much lessened on the underground system.

DR. R. W. SHUFELDT has made measurements of the leaps of the Mexican hare (*Lepus callotis callotis*) and the sage-hare or rabbit (*L. Sylvaticus Nuttalli*) on the snow-covered plains of New Mexico, the animals having been stimulated by a scare from the shot of a fowling-piece. The Mexican hares cleared twelve and thirteen feet, while the Mexican rabbits could leap fully six feet, and, in one case, more than seven feet. At their common rate of going, he says, "the hare rarely clears more than four feet at any single leap, while the rabbit is satisfied with rather more than two feet, and, when quietly feeding about the sage-bush, the tracks made by an individual of either species may actually overlap each other."

THE Municipal Council of Paris intends to found, in connection with one of the prominent public institutions, a chair of Philosophical Zoölogy, with a special view to the propagation of the Darwinian doctrine of evolution. Among those who are named as probable occupants of this chair, the fittest is said to be M. Alfred Giard, late of Lille, but now of Paris, who has taught this doctrine and made researches regarding it, and has gathered around him a school of young zoölogists.

A WRITER in "Chambers's Journal" has suggested that, if school-prizes are to be continued, their character might be improved, and they might be made to contribute to real zeal in the pursuit of knowledge, and to become a stimulus to further effort, by giving a part of their value, at least, in the form of privileges of free tuition in some school where the recipient's favorite branches could be studied for a longer time and to greater proficiency; while a smaller part might still be applied to the provision of a medal, as visible evidence of the merit and distinction.

OBITUARY NOTES.

DR. MAXIMILIAN SCHMIDT, an eminent geologist, and Director of the Zoölogical Gardens at Berlin, has recently died, at the age of fifty-four years.

PROF. HANS CARL FREDERICK CHRISTIAN SCHJELLEMP, the Danish astronomer, died at the Copenhagen Observatory, November 13th. He was born in 1827, distinguished himself in mathematics at the Polytechnic School in Copenhagen, was appointed observer in the old observatory at Copenhagen in 1851, and succeeded to the new one when it was completed. He determined the orbit of the comet of 1580, made zone observations of the stars between 15° of north and 15° of south declinations, translated Sufis's descriptions of the fixed stars from the originals, contributed to the journal "Copernicus" articles on the astronomy of the ancients, and published a catalogue of the "red stars."

ADMIRAL SIR ASTLEY COOPER KEY, of the British Navy, died March 3d, in the sixty-seventh year of his age. He had during his service held the positions of Principal Naval Lord of the Admiralty and Director of the Royal Naval College, and had done much in behalf of the application of science to the wants of the navy.

PAUL BERT.

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SAFETY IN HOUSE-DRAINAGE.

By WILLIAM E. HOYT, S. B.

IT was a little more than five years ago that Dr. Frank Hastings Hamilton wrote for "The Popular Science Monthly" an article on sewer-gas, in which he vigorously arraigned science for its failure to keep pace with civilization in the disposal of household wastes. The effect of Dr. Hamilton's article was quite unprecedented. His forcible presentation of facts and theories so affected the popular mind as to create an almost universal distrust of sanitary science, and, even at the present time, the idea prevails that plumbing fixtures in our houses are always a source of danger. In magazines and newspapers the discussion has been from time to time renewed, and the same pessimistic views are almost invariably held that were first advanced by Dr. Hamilton.

It is a subject of vital interest now to determine if this unfortunate condition of things described as existing five years ago still continues. We should know the truth or falsity of the assertion that there has been in late years a retrograde movement, hygienically considered, in substituting house-drains and sewers for the old earth-vaults and cess-pools. Can we have plumbing fixtures in our houses without danger to health, or must we make great concessions in comfort and convenience for the sake of safety? The question has lost none of its interest since Dr. Hamilton called into question the trustworthiness of sanitary science. Let us examine the evidence upon which the indictments have been made. We shall find, in the first place, that there is a surprising popular ignorance in regard to the literature of the science. How many well-informed persons are there, who know of the work of Pettenkofer, of Carmichael, of Naegeli, and Wernich,

and Miquel, and a score of other scientists abroad, whose investigations have added so much to our knowledge of specific dangers to health and the means of overcoming them? And how many have heard of the careful and painstaking sanitary work of able scientific authorities in the United States? The labors of Waring and Putnam and Pumpelly and Smyth have been no less valuable, but the records of their investigations and experiments, although of great popular interest, are not widely known. No one can speak or write intelligently on sanitary topics without familiarity with this literature; but the writers who have arraigned sanitary science so severely are those who are most ignorant of its methods and its principles.

Let us consider the popular notion already alluded to—that we can not safely have plumbing fixtures in our houses. It is evident that the present requirements of comfortable living demand a reasonable number of convenient baths, closets and basins, and all the usual apparatus of this kind which modern civilization has introduced into the houses of the well-to-do. We can hardly consider these as luxuries. They are, in fact, absolute necessities; and to dispense with them would cause great inconvenience and inconceivable loss of comfort, and even of health. In compliance with the demands of a high civilization, sanitary science has been directed persistently toward the perfection of means to obtain all possible conveniences for free and frequent ablutions, as well as for the immediate and complete removal of household wastes. What evidence is there that science has failed in this particular? It is said that costly houses fitted with elaborate and expensive appliances for luxurious living have been often invaded by disease and death, and that the cause of this has been sewer-gas. These facts can not be disputed, but it is absurd to claim that science is at fault in this matter. The unfortunate results of such cases are invariably due to ignorance and empiricism.

In his census reports, Dr. Billings estimates that, in the United States, one hundred thousand deaths occur every year from strictly preventable diseases alone. This is unquestionably a very moderate estimate, and, if there are reckoned also twelve cases of serious illness for every death, we see what a great amount of suffering results from ignorance of sanitary principles.

But how is this ignorance manifested? Are not our architects competent to deal with the problem of household sanitation? It will be said, perhaps, that it is the province of the architect to direct the entire work of house-building, and to arrange every detail of the fittings. But it should be considered that the science of sanitation is broad and comprehensive. Years of study and of experience in sanitary work are necessary for a proper under-

standing of the subject. It is perhaps unfortunate that there is so little in the severe and unpleasant details of this work to commend it to those whose tastes have led them to the study of the more attractive principles of artistic construction and the science of æsthetics. An architect should have the soul of an artist, but there are few men whose nature is so broad as to combine truly artistic tastes with a love for the details of difficult mechanical work, involving the necessity for undertaking comprehensive and exact scientific research. It is the province of the engineer to engage in an occupation of this kind. His natural inclinations and his rigid training in scientific pursuits fit him especially for the direction of matters relating to drainage and sewage disposal.

If we take the testimony of competent sanitary authorities who are constantly employed in the design and execution of systems of house-drainage, it will be found that there are very few architects who can be trusted to prepare specifications for plumbing. In fact, the work of the average architect, in planning and supervising constructions of this kind, has been found to be almost universally clumsy and unscientific. This has been the experience of the writer in almost every case where his services have been called into requisition to remedy serious defects in household drainage which have sometimes caused inconceivable loss and misery. In this connection there may be quoted some pertinent remarks of one of our best known and most reliable sanitary authorities, Colonel George E. Waring, Jr., who recently wrote: "I have had much experience in connection with plumbing work in houses designed and built by some of the first architects of the country, and I do not hesitate to say that, in my experience, I have not found a single case where the architect has made use of the plainest and best developed knowledge of the day on this subject. I may be mistaken, but I think that no architect with whose work I have had to do either wrote or understood the specifications under which the plumbing was to be done."

Perhaps we shall be able to see now a little more clearly why some of our most costly dwellings are veritable whited sepulchres. But what of the plumbers? How is their status to be defined in this connection? From motives of economy, a plumber is sometimes employed to take charge of an entire scheme of house-drainage, and the employer intrusts everything to his care. The unfortunate results of such confidence are seen continually in the unsanitary condition of innumerable houses of rich and poor alike in all of our large cities. There is hardly a parallel to be found in any other occupation where men handle implements of death with such recklessness and with such disastrous consequences. The plumber is a mechanic, and perhaps a tradesman. His opportunities for study are few, and his inclina-

tions are rarely toward self-improvement or useful learning. He blindly considers it his interest to induce his customers to allow him to use the greatest amount of material possible in his work, and the greater the complication of arrangement of pipes and fixtures with the consequent mystification of his patrons, the

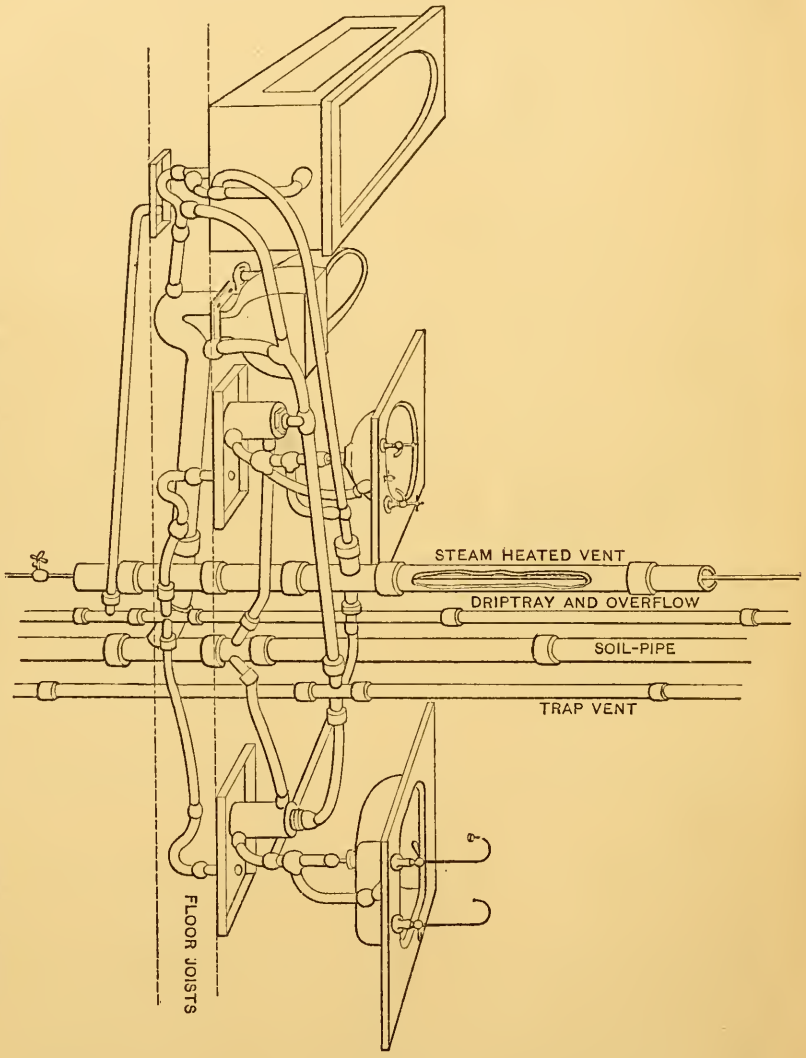

Fig. 1.—Showing the Actual Arrangement of Waste-Pipes and Vents about a Group of Plumbing Fixtures in a House in New York City. There are sixty-three joints.

more absolute becomes his power, with largely increased possibilities of extra charges.

Compare the plumber and his "helpers" with the young mechanics in almost any good machine-shop, and decide which occupation engages young men of greater intelligence and skill in manual work. Obstinately following tradition, our plumbers

generally regard all improved methods developed by the application of scientific principles as dangerous innovations, interfering with the ancient and time-honored traditions of their unprogressive fraternity.

There is another and a stronger obstacle to scientific progress in

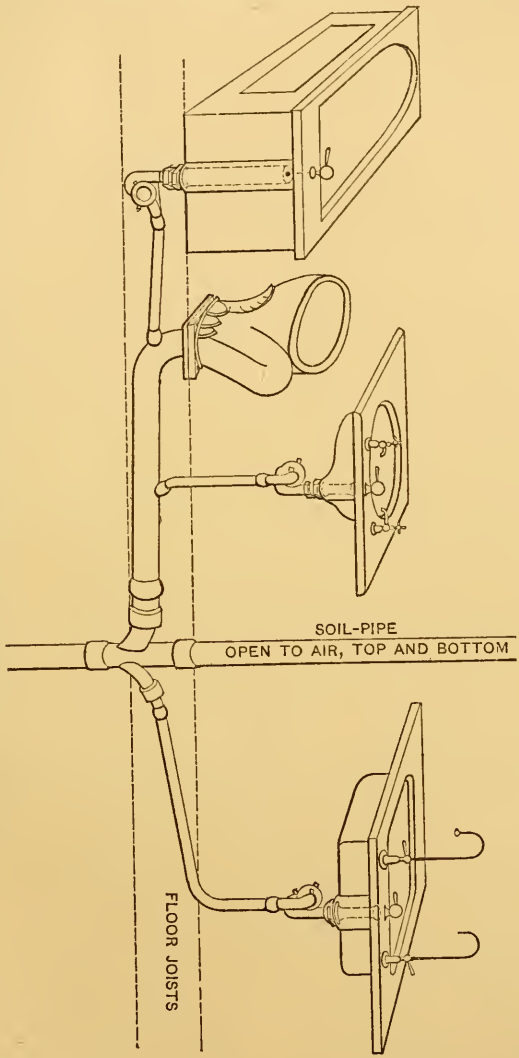

Fig. 2.—The Same Fixtures, with the Proper Arrangement of Waste-Pipes.

sanitary matters. This is to be found in the powerful influence of capital. In our large cities are the extensive wholesale establishments of dealers in plumbing fixtures and supplies. The amount of money invested in the stock and patterns for manufacturing certain forms of plumbing appliances is enormous. These articles are, many of them, extremely unsanitary and even danger-

ous when applied to actual use, but the profits on their sales are large, and the introduction of better and more simple forms of apparatus would seriously disarrange the existing order of things. The abolition of the trap-vent laws, for example, would cut out a thousand pounds or more of useless iron and lead pipes from the plumbing of every good-sized house. Manufacturers and dealers would suffer heavy losses, and so the vast interests involved are carefully guarded by all the resources which money can command in municipal legislation. This influence has extended even to the press; and we see tradesmen's journals persistently ignoring scientific progress and upholding still the old methods which are to enrich unscrupulous manufacturers and their clientage of uneducated mechanics. It is for the interest of invested capital that plumbers be kept as ignorant and as unprogressive as possible.

In this conflict of ignorance and prejudice with science, it is not difficult to trace still further the cause for so much popular distrust. If the most common defects in the apparatus for ordinary house-drainage could be clearly understood, it would be readily seen that the want of confidence in plumbing appliances arises mainly from a general misapprehension regarding their real imperfections. We know, for example, that sewer-air, or sewer-gas, as it is improperly called, finds its way continually into many houses, and frequently causes disease and death. How does this sewer-air gain an entrance? If you consult your plumber, he will deny that there is any possibility of such a defect existing in the drain-pipes and fixtures he has put in. But your physician will tell you that the symptoms of illness of some member of the household show unmistakable evidence that the patient has been poisoned by sewer-air. A thorough examination of the drain-pipes shows that they are securely jointed, and that there are no leaks in them. Nevertheless it is certain that sewer-air gains an entrance to the house in considerable quantities, and after a time it is discovered that the poisonous air finds its way in through the traps attached to the basins and sinks and water-closets. A word of explanation may be necessary in regard to these traps. Although of a great variety of forms, they are all essentially a device for allowing waste-water to flow through them from the fixtures to which they are attached into the drains, and to prevent air or gases from passing in the opposite direction into the house. The resisting medium in most cases is a water-seal, consisting of a small body of standing water in the body of the trap. When it is found that sewer-air passes freely through these very traps that have been designed to keep it out, the inference is almost irresistible that the water-seals are at fault, and that water is not a suitable medium to be used for this purpose, since air from the drains apparently forces an entrance through it.

It is at this point that the serious error of a false assumption is so frequently made. The truth is, that sewer-air does not come into our houses in any appreciable quantity through the water-seals of traps. On the contrary, it passes through the trap when the seal has been lost—when the water has been accidentally withdrawn or forced out. The broad principle of the efficiency of water-seals is not affected by these apparent failures. The difficulty is in maintaining the seals—in keeping them intact and secure against all the various adverse influences that may affect them. And here the aid of sanitary science must be sought; for the plumber's art has been powerless to devise traps that will protect our houses from the foul air of the sewers. Every failure in this attempt has been from a disregard of principles that have been well established by competent authorities. What are these principles ?

For many years, skillful chemists, devoting themselves to sanitary work, have been carrying on careful investigations regarding the possibility of the passage of sewer-air and disease-germs through the water-seals of traps. The definite determination of this question is necessary in order to establish proper means of defense against the dangers we have already considered. It is evident that the form of traps and other apparatus to be used for this purpose will depend upon a conclusive demonstration of the truth or falsity of the views of those who have maintained that water as a resisting medium gives no protection in this particular The evidence which we have upon this point is clear and conclusive.

As long ago as 1877, Naegeli, an eminent scientific authority in Munich, established conclusively that disease-germs can never be given off from a liquid at rest in any ordinary temperature. Later researches by Carmichael, Wernich, and Miquel, chemists and sanitarists of world-wide reputation, corroborated the truth of Naegeli's demonstrations in every respect.

In 1880 the United States National Board of Health, through the efforts of Colonel George E. Waring, Jr., secured an appropriation for the purpose of investigating the same subject. Two able chemists, Prof. Raphael Pumpelly and George A. Smyth, Ph. D., were employed to conduct the investigations. A long series of careful and delicate experiments was made, extending through several months, and the published report of the results forms a valuable contribution to the literature of sanitation. The conclusions in this instance are precisely the same as those of the other authorities above referred to—viz., that disease-germs can not be given off to the air from any quiescent liquid at a normal temperature.

The experiments of Dr. Neil Carmichael, Fellow of the Faculty

of Physicians and Surgeons at Glasgow, are particularly interesting. They were conducted with rare skill and an honest endeavor to ascertain the worst conditions existing ordinarily in houses containing the usual forms of plumbing fixtures. Dr. Carmichael attached his experimental apparatus to the traps of two common water-closets connected with a foul soil-pipe leading into an old sewer. The outlet of this sewer, some three hundred yards away, was submerged at high tide, so that sewer air or gases were forced back toward the houses. The top of the soil-pipe used for the experiments was ventilated by a two-inch pipe passing through the roof to the outer air; and, to impose the most severe conditions possible, some of the experiments were conducted with the soil-pipe tightly closed at the top. The average result of many different experiments by Dr. Carmichael is given in the following table:

Quantitative Determination of Gases which passed through Water-Traps (A and B) in Twenty-four Hours.

GAS.		Old water-closet trap (A).	Kitchen trap (B).
		Grains.	Grains.
Soil-pipe open at the top...	Carbonic acid.....	7·084	7·084 10·470
	Ammonia.....	$\frac{1}{217}$, $\frac{1}{250}$, $\frac{1}{350}$, $\frac{1}{400}$	$\frac{1}{100}$, $\frac{1}{200}$
	Sulphureted hydrogen .	$\frac{1}{100}$	$\frac{1}{60}$
Soil-pipe closed at the top...	Carbonic acid.....	32·032	17·063
	Ammonia	.....	$\frac{1}{400}$
	Sulphureted hydrogen .	$\frac{1}{90}$	.....

Putrid organic vapors, if present, are included in the ammonia.

With the top of the soil-pipe closed, it will be seen that the amount of gases passing through the water was considerably increased, but was still extremely small. And this represents the worst possible condition that can exist in houses which are properly protected by traps having water-seals.

The deductions of Dr. Carmichael from these experiments are here given in his own words, taken from the "Proceedings of the Philosophical Society" of Glasgow:

"These are the quantities of the only sewage gases existing in the soil-pipe in estimable quantities which pass through an ordinary water-closet trap in twenty-four hours. Diffused into the atmosphere of a house during this time, these quantities are, from a health point of view, quite inconsiderable—perfectly harmless. Thirty-two grains (the largest quantity of carbonic acid) is less than the quantity of the same gas given off when a bottle of lemonade is opened. A man exhales in the same time about four hundred times the amount which passes through the trap from an unventilated soil-pipe."

Dr. Carmichael then explains in detail his experiments in re-

gard to the passage of disease-germs through traps, and concludes as follows:

"The liquids in all these tubes and flasks, though kept from two to five months at cultivation temperature, have remained perfectly clear, and even when examined with a lens multiplying nine hundred diameters, exhibited no trace of life. The conditions of these experiments seem to me crucial, and to warrant the conclusion that germs do not pass through a sound water-trap. If no germs pass through, then it is certain that no particles pass through, because the particles in a soil-pipe are putrid, and because the passage of organic particles through water necessarily impregnates them with germs. Clearly, therefore, such particles as epithelium from the bowels in typhoid fever, containing the typhoid contagia, are cut off and effectually excluded from the house by a sound water-trap. Water-traps are, therefore, for the purpose for which they are employed—that is, for the exclusion from houses of injurious substances contained in the soil-pipe—perfectly trustworthy. They exclude the soil-pipe atmosphere to such an extent that what escapes through the water is so little in amount and so purified by filtration as to be perfectly harmless; and they exclude entirely all germs and particles, including, without doubt, the specific germs or contagia of disease."

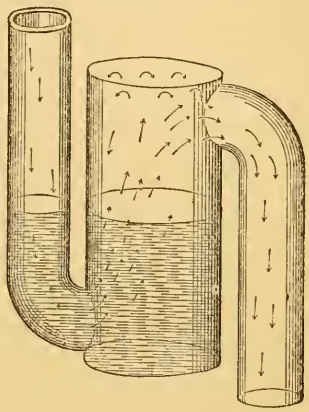

Fig. 3.—A Pot-Trap, showing how Water escapes by Siphonage.

The testimony of these distinguished scientists must be regarded as conclusive in the absence of contradictory evidence. Is there such evidence on record? Let us examine the authorities. It is claimed that different results have been obtained in a few instances by other investigators. Some years ago, Prof. Doremus showed that gases would pass through water from one test-tube to another. But it must be remembered that the gases used in these experiments were in a highly concentrated form. Such conditions as were then imposed are absolutely impossible outside of the chemical laboratory. The atmosphere of sewers, drains, and soil-pipes is in reality ordinary air containing less than one per cent of the gases and particles given off by decomposing sewage. The results of over sixty analyses made by such men as Dr. Letheby, Dr. Miller, of London, and the late Prof. Nichols, of Boston, show an average of only four tenths of one per cent of carbonic acid with mere traces of sulphureted hydrogen, marsh-gas, and ammonia. The putrid organic vapors, and the putrefactive

germs, particles, and spores of fungi, were found also in extremely minute quantities. But the important consideration is, that these germs, particles, and spores, the most dangerous elements of sewer-air, can not escape from the water-seal, and that the quantity of carbonic acid, and the accompanying gases arising from sewer-air, which, even under the worst conditions, can pass through water, is minute and utterly harmless. The experiments of Prof. Doremus were therefore irrelevant and valueless as applied to a determination of the efficiency of trap-seals.

It has been said, too, that Mr. Paton, a chemist temporarily in the employ of the health department of the city of Chicago, at one time observed the passage of sewer-gases through the seal of a trap. Since frequent reference has been made to this experiment, it is fortunate that the report of Mr. Paton is still accessible. An examination of the document in question, and of a drawing of the apparatus employed in the experiment, shows at once that the results obtained have no relation whatever to the subject we are considering. Mr. Paton, instead of trying to ascertain if gases would find their way unassisted through a trap-seal, adopted the very original method of forcing them through the water into a vacuum by atmospheric pressure. A more absurd proceeding could hardly be imagined, were it not for the fact that these experiments were in reality conducted to determine the value of a so-called germicide which the health officers had been asked to examine.

There is, then, absolutely nothing in the form of reliable testimony that can be brought forward to contradict in any particular the positive and comprehensive statements of the eminent scientific authorities previously referred to.

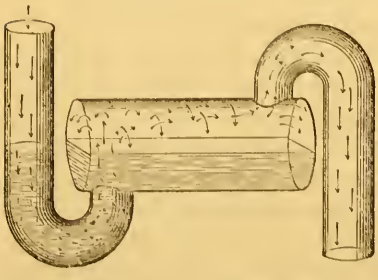

Fig. 4.—First Step in the Development of an Anti-siphonic Trap.

It is established beyond question that water may be safely used as a seal for traps. But may there not be a better and more complete medium of resistance against sewer-air? The attempt has been made to substitute mechanical valves of various kinds in place of the water; a seal of mercury has also been employed, and, in some instances, balls of rubber and of metal have been used in conjunction with water; but these substitutes and additions have, in every case, proved extremely objectionable, on account of obstructing the outward flow of waste-water, and so causing accumulations of filth in the traps and water-pipes.

It is not at all probable, then, that any better contrivance than

that of a water-seal will ever be devised for the protection of our houses from the poisonous air of drains and sewers. But, having determined this point, we find that there are still serious difficulties to overcome in making traps that will not lose their seal. In our house-drains there are always certain influences that tend to lower the water in the traps, or even to draw it forcibly out, and then, of course, with the seal destroyed, there is no protection against sewer-air. Siphonage, capillary attraction, and evaporation are among the most potent of these hostile agencies. Certain atmospheric disturbances also, such as strong draughts of air, may produce the same effect, and the trouble which has resulted from causes of this kind has, for the most part, been ignorantly attributed to the supposed easy permeability of the water as regards the dangerous gases of decomposition in our sewers.

Various means have been devised to prevent siphonage of traps. One of the most common is that of trap-ventilation or back-venting, so called. In its most common form, it consists of a system of air-tubes connected with the crown of each trap, and running by one or several lines of larger pipes to the outer air above the roof of the building. It was expected that this device would prevent entirely the siphonage of traps, and in several cities plumbing laws have been framed requiring all traps to be vented in this manner. But in hundreds of houses to-day, where this method of protection has been adopted, we find sewer-air entering freely through traps that continually lose their seal. And it will be easily seen, after a little reflection, that this fallacious remedy causes quite as serious evils as those it is designed to obviate. In the first place, if the ventilation of the trap by this method is effective, a current of air is introduced close to the water-seal, and this circulation must induce evaporation of the water in the trap, rapid in proportion to its efficiency as a ventilator, so that the seal is soon destroyed. This frequently happens to the traps of basins and other plumbing fixtures that are not in every-day use. Again, it is found that the friction of the air in the vent-pipes is sometimes so great as to prevent them from performing their proper function. In this case, where there is the slightest retardation in the passage of air through the vent, siphonage takes place and the seal of the trap is destroyed as readily as if the vent-pipes had not been used. Again, the lower orifice of the air-pipe is frequently obstructed by filth thrown up to the crown of the trap as the waste-water passes rapidly out. In time, this obstruction increases to such an extent that the vent-pipes can not give a free passage for the air, and there is consequently no relief for the seal when siphonage occurs. It should be observed, also, that in modern houses, where trap-ventilation is considered to be most perfect, there is still another set of air-

tubes, running from the inside of every trap-seal to the larger air-pipes extending through the roof of the building. With this double ventilation, the deleterious effect of air-currents on trap-seals is, of course, greatly increased.

Some idea of the complication and enormous expense of this system may be formed from an illustration of its application to a group of four plumbing fixtures in adjoining rooms on one floor of an elegant residence recently built in New York city (Fig. 1). It will be seen that the air-pipes require an almost complete duplication of the waste and soil pipes. This, of course, adds greatly to the cost of the plumbing, and increases the danger from imperfections in the largely augmented number and length of pipes with their multifarious joints.

Fig. 2 shows the same number of fixtures in the same relative position, but the plumbing is arranged in accordance with the requirements of modern methods as developed by the application of scientific principles.

Not long after the adoption of the fallacious device of back-venting, it became evident that more efficient means of guarding against the dangers of sewer-air were necessary, and persistent

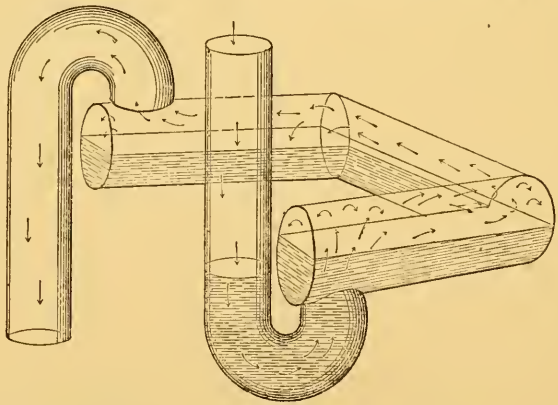

Fig. 5.—Second Step in the Development of an Anti siphonic Trap.

effort was directed toward devising better methods of house-drainage. The result has been the attainment of a new order of things by the recognition of scientific principles previously ignored.

For the development of this science, credit must be given mainly to an accomplished sanitarist of Massachusetts, Mr. J. Pickering Putnam, whose experiments and investigations on subjects relating to household sanitation are unquestionably the most thorough and complete that have ever been put on record. The first of this series of experiments was made for the Board of Health of Boston, in 1883. Subsequently, special demonstrations

were shown before the Suffolk District Medical Society of Massachusetts, the Boston Society of Architects, and others. The results have been published in the "Boston Medical and Surgical Journal," the "American Architect," the "Sanitary Record" of London, and other periodicals.

Without referring now directly to the experiments and investigations, we may consider briefly certain principles which have been established by them. The first and cardinal principle of science as applied to house-drainage is simplicity. In the place of a wilderness of pipes tangled in hopeless confusion about every fixture, modern science demands that there shall be only a simple and positive system which shall act with directness and certainty in every case. The old air-pipes from traps are discarded. There are fewer joints, and the danger from leakage is lessened. Instead of traps that easily lose their seal, notwithstanding the relief-pipes attached, traps are now used that in themselves will resist the hostile influences of evaporation and siphonage. The new system demands that basins, sinks, baths, and water-closets shall be so constructed as to act after the manner of flush-tanks, and scour the whole system of waste-pipes at each discharge. It requires that there shall be no hidden and inaccessible recesses in plumbing fixtures, where filth may collect and putrefy, so as to become offensive and dangerous. The absolute *prevention* of serious evils is considered of far greater importance than means to palliate them.

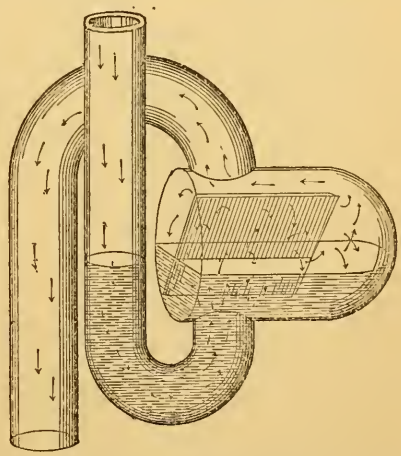

FIG. 6 —SHOWING THE PRINCIPLE OF AN ANTI-SIPHONIC TRAP.

Such, in brief, are the leading principles of the new method which are directly opposed to those of the old. We may look a little more closely into the details of their execution. Simplicity has been secured, as already stated, by the rejection of complicated vent-pipes, and by the adoption of traps secure against siphonage or evaporation. The gradual development of one form of such a trap is an interesting study, but there is space only to outline the principles upon which it is constructed.

The experiments of Mr. Putnam on trap-siphonage showed in what manner the water is withdrawn from traps by siphonic action. It was seen that air, rushing through the seal to fill a vacuum beyond, threw the water upward and outward through

the orifice of the trap into the waste-pipe, as shown by arrows in the sketch of a pot-trap (Fig. 3). It was observed, too, that a part of the water struck the top of the trap and was reflected back in the form of spray. This suggested the possibility of retaining the water in the trap under siphonic disturbance by repeated deflections from reflecting surfaces. Various experimental patterns of traps were made by Mr. Putnam, as shown in Figs. 4 and 5; and, finally, the form shown in Fig. 6 was found to be anti-siphonic and self-cleansing under all conditions that exist in good plumbing practice. It has four reflecting surfaces to deflect the water from the outlet, and the seal is so deep and the construction such as to enable it to resist both evaporation and capillary attraction.

The general principle that all plumbing fixtures shall act as flush-pots, so that the waste-pipes shall be automatically cleansed, is of great importance. A strong flushing action is secured by making the outlets of the fixtures as large as the waste-pipes

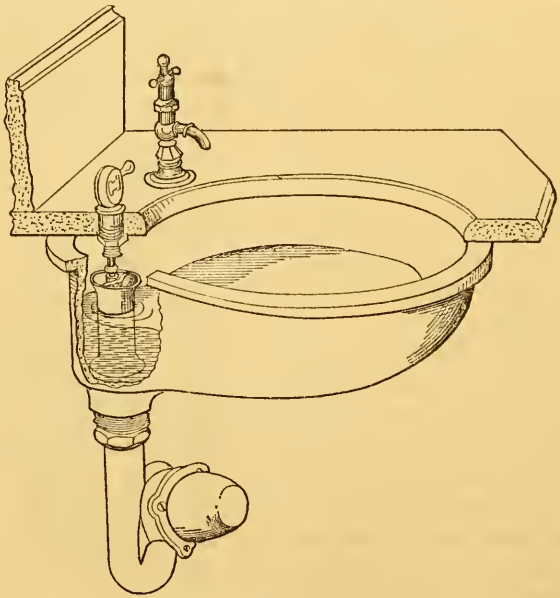

Fig 7.—A Basin, showing the Proper Form of Overflow-Pipe for all Lavatory Fixtures, and the Arrangement of Outlet and Trap to give Thorough Flushing to Waste-Pipes.

themselves, and by the use of traps having a free water-way, with no balls or mechanical valves to obstruct the flow of waste-water. Aëration is effected by the admission of a free admixture of air into the waste-pipes, automatically forced in by the water escaping from the fixtures above.

The abolition of inaccessible filth-collecting recesses in modern plumbing has necessitated a complete change in the construction of the old forms of appliances with which we have been familiar.

Our basins, baths, and pantry-sinks have been made with overflow openings connecting with pipes concealed from view and entirely inaccessible for cleaning. These overflow-pipes invariably become receptacles for filth, and the emanations from them are always offensive and dangerous. The new patterns of basins, sinks, and baths have the overflows in the form of a short, movable stand-pipe set in a recess at the back or end of the fixtures. This stand-pipe serves also as an outlet-plug. When raised from its seat by a simple lifting device, it permits the escape of waste-water, and by a single movement it is readily detached from its place for cleaning (Fig. 7).

The overflow-pipe of our common set-basins forms a receptacle for the accumulation of a thick deposit of filthy slime in its interior, which, by putrefying, pollutes the air of houses to a dangerous degree (Fig. 8). Since the interior of this pipe is quite inaccessible for purposes of cleansing, there is no remedy for the evil except by abandoning the use of this old form of fixture, which has also other equally objectionable features. The chain attached to the outlet-plug invariably collects a great quantity of filth in its numerous well-protected recesses and on the entire irregular surface of the links. It is almost impossible to remove this filthy accumulation by any ordinary means, and the continued use of a household fixture of this kind by different persons is offensive to good taste, and violates the generally accepted standards of personal cleanliness established by ordinary hygienic principles.

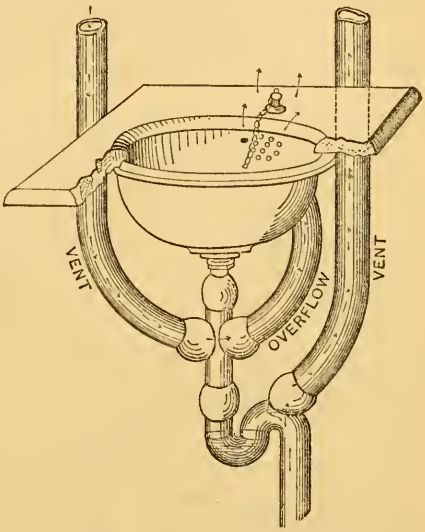

Fig. 8.—Set-Basin, with Common Overflow-Pipe and "Fore" and "Back" Vents.

Our common water-closets in general use have so many serious faults of design and construction as to demand especial consideration in this connection. Some of the most costly and elaborate patterns recently designed and put upon the market are dangerous and unfit for use. Delicately tinted and fancifully molded shapes of porcelain or earthenware are no guarantees of safety. Sanitary requirements in the construction of water-closets are so clearly defined that the essential features can be readily understood from a brief enumeration.

First of all, the water-seal must be deep—never less than four inches—and this seal must be exposed to view for reasons which will be hereafter given. Again, there must be a considerable depth of standing water in the bowl of the closet, to deodorize fecal matter and to secure cleanliness. The outlet of the bowl must also be completely submerged, to prevent its becoming foul and offensive from use. The closet should invariably have some device for maintaining the water-seal against loss from evaporation.

The traps of water-closets are especially exposed to the danger of losing their seal. This happens frequently from the effect of wind and other atmospheric disturbances. An open fire in an adjoining room, or a ventilator near by, may cause this loss of seal from sudden draughts of air, and sewer-air frequently has free entrance into houses for hours and even days at a time when the danger is not suspected by the occupants, since the water-seal of the trap, in badly constructed fixtures, is wholly concealed from view.

In a series of careful experiments, conducted by the writer, it was observed that even in well-ventilated soil-pipes, strong air-currents prevail to such an extent as to cause the water-seal of traps to fluctuate with a quick rise and fall, so that enough water is soon spilled over the outlet of traps to unseal them entirely. The results of these experiments have recently been fully confirmed by other investigators.

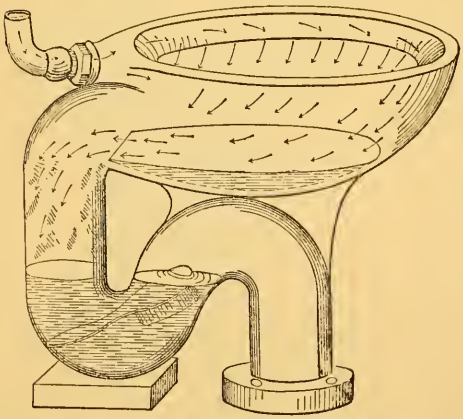

Fig. 9.—"Wash-out" Water-Closet, showing how Accidental Obstructions may remain undetected in the Trap which is concealed from View.

Of course, the more shallow the seal, the greater is the danger of its being destroyed from any cause; and for this reason a considerable depth of water is required in the trap of every water-closet. It is necessary, also, that this seal should be plainly exposed to view, in order that any loss of water from the causes just mentioned, or by leakage, may be readily noticed.

But it will be observed that the water-closets in most common use have an extremely shallow seal. The reason of this is that, with the imperfect means employed for flushing them, a greater depth of water in the trap can not be allowed, since it would seriously retard the outward flow of waste-water. The common

"wash-out" closets, so called, with the allied forms of "short hoppers" and "long hoppers," and the complicated and dangerous "plunger," "valve," and "pan closets," all depend on the weight of a stream or body of water falling from above to force out the waste matter from the bowl of the closet through the trap below. This force is rarely sufficient to give proper flushing action, even with a shallow trap-seal. A deeper trap would oppose too much resistance to the discharge of waste matters from closets of the kind just referred to. Cleanliness and safety can be secured only by a greatly modified form of construction, and by the employment of totally different means for flushing. The principles of the siphon and of the water-jet have been applied successfully to this purpose, so that deep and safe water-seals can be used which are in full view at all times.

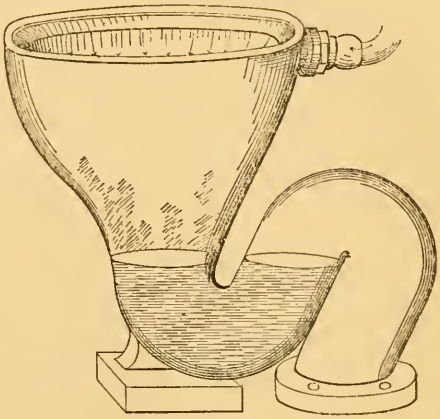

Fig. 10.—"Short-Hopper" Water-Closet, showing Accumulations of Filth in the Bowl.

The illustration, Fig. 11, shows a form of siphon closet devised by Colonel Waring. The flushing is effected by opening a valve in a tank above, which produces a quick rush of water into the bowl. This fills the longer arm of the siphon and the weir-chamber below by the overflow through the neck or short arm. As soon as this takes place, the contents of the bowl are forcibly drawn out by siphonic action and discharged into the waste-pipe, after which the normal level of the water in the bowl is re-established by an after-fill from the tank.

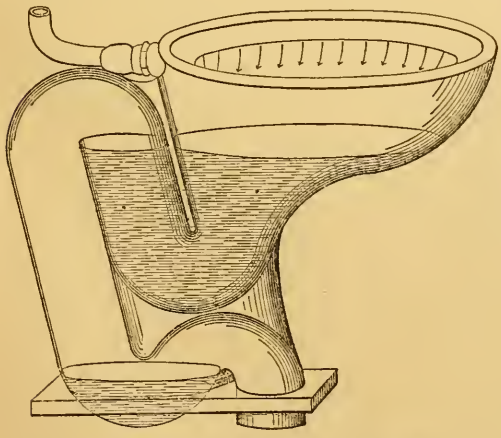

Fig. 11.—A Siphon Closet, with Deep Water-Seal.

There are, however, certain so-called pneumatic or siphon closets which should be carefully avoided on account of their having a double trap. This principle of construction is directly

opposed to sanitary requirements. Double traps are not permissible in any case for a single plumbing fixture, since their use greatly retards the outflow of water and waste matter, thereby causing accumulations of filth that are dangerous and offensive. It should be observed, too, that in these closets the second trap gives no additional protection against sewer-air, since a relief-pipe from the air-space between the traps opens directly into the apartment in which the closet is placed through a concealed orifice above the flushing-tank. The main trap is also completely hidden from view in a part of the closet entirely inaccessible.

Figs. 12 and 13 show a trap-jet closet devised by Mr. J. Pickering Putnam to conform to the requirements of the essential principles already stated. Its construction is extremely simple. It has a deep and perfectly protected trap-seal exposed to plain view in the bowl of the closet. The flushing-pipe stands always full of water, equilibrium being maintained by atmospheric pressure. Should the water in the bowl be lowered by evaporation or siphonage, air will enter the flushing-pipe through one of the openings at the lower end, and water immediately descends to restore the loss to the trap-seal.

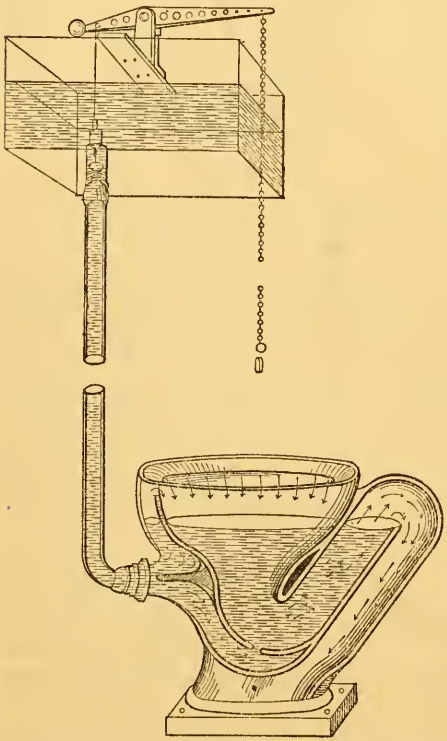

Fig. 12.—Showing the Principle of a Trap-Jet Water-Closet. For convenience of illustration the inlet and outlet are here represented on opposite sides of the bowl.

Fig. 14 shows a simple illustration of this principle in the sketch of an inverted bottle with the mouth submerged in a basin of water. The contents of the bottle remain undisturbed so long as the level of the surface of the fluid in the basin is constant; but if this be lowered, so that air enters the mouth of the bottle, a corresponding volume of water escapes from the bottle into the basin to restore equilibrium. The application of this principle of protection to houses which are closed and left untenanted during several months of the year is manifestly of great importance. Our city residents, after a summer passed at the sea-shore, or in

the fresh, pure air of the mountains, often return to houses which have upholstered furniture, carpets, curtains, and heavy draperies saturated with the foul and poisonous air of sewers and drains which has had unrestricted entrance to the deserted houses for months at a time.

It will be noticed that the lower end of the flushing-pipe shown in Fig. 12 is divided, one orifice being connected with the flushing-rim and the other with a small opening at the bottom of the

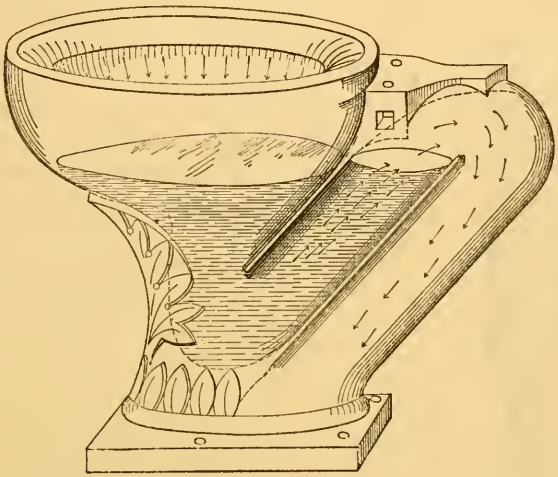

Fig. 13.—Trap-Jet Closet, showing the Actual Shape.

bowl. When the valve in the tank is raised, the lower opening allows a strong jet of water to be thrown upward toward the outlet. This forcibly expels a portion of the contents of the bowl and lowers the water and waste matters into the neck, whence they are ejected by the combined action of the upper and lower flushing-streams. A strong wash descending from the flushing-rim cleanses the bowl thoroughly and afterward refills it to the level of the trap-outlet. The discharge of the closet is almost noiseless, since the lower orifices of the flushing-pipe are submerged.

Considerable space has been given to a description of the most common defects of plumbing fixtures, for the reason that these imperfections are usually the unsuspected source of danger to life and health in houses where the plumbing is most elaborate and costly. Poor material in the drain-pipes and leaky joints are readily recognized perils that may be easier avoided because they are better understood. It may be well, in conclusion, to note a few important points that should be observed in every well-designed system of house-drainage.

The plumbing should be concentrated as much as possible, so

that the various fixtures shall be near one vertical line of soil-pipe extending through the house from basement to roof. This soil-pipe should not be less than four inches in diameter, with an extension above the roof of a size two inches larger, to prevent obstruction by frost. The upper end of this extension should be open, without an attachment of hood, or cowl, or bend, and should not open near a window or ventilator. The soil-pipe should never be connected in any way with a chimney-flue, since downward draughts, when the flue is cold, or when strong winds are blowing, will, in such cases, circulate sewer-air freely through the house.

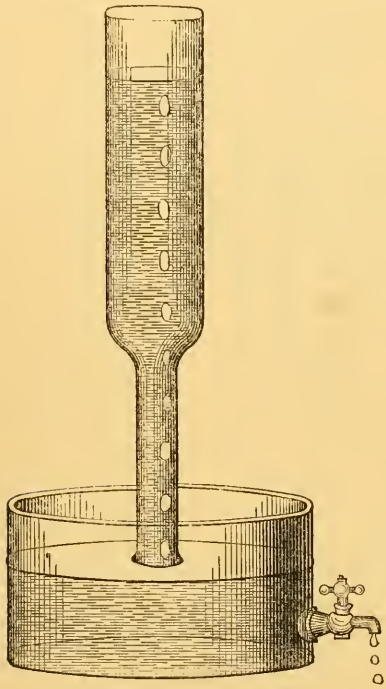

FIG. 14.—INVERTED BOTTLE. To illustrate the principle of an automatic supply to a water-closet trap affected by evaporation or other causes.

The soil-pipe, if of cast-iron, should be of the greatest thickness made for this purpose, as a safeguard against hidden defects in the iron and the danger of splitting at the joints. Soil-pipes and water-pipes should have in all cases as few joints as possible, and these should be made with the greatest care. The well-known Durham system, which employs screw-joints for the connections of long sections of wrought-iron pipes, undoubtedly gives much greater security against leakage than the more common methods of plumbing, which require all joints to be made by calking with lead.

No drain-tiles or earthenware pipes of any kind should be used in the house or under the foundations to convey sewage. Certain local conditions may sometimes require that drains for subsoil water shall be laid within the cellar-walls, and in such cases it is best to have a separate line of drainage entirely independent of the sewer, but, if it is necessary to deliver this water into the main house-drain, the connection must be made at some distance from the house, in such a way as to have a freely ventilated air-space between the two systems of drains, so that there is no opportunity for the foul air from the sewer to enter and circulate through the open-jointed line of earthen tiles beneath the cellar bottom. Almost equal care is necessary when drains for soil-water are laid just without the cellar-walls, since air from the

soil surrounding the foundations is drawn freely into our dwellings, and any pollution of this soil-atmosphere must occasion serious danger.

In a like manner, rain-water conductors are to be cut off from a direct connection with the house drain or sewer. The upper end of conductor-pipes opening near windows may readily convey sewer-air into the house, unless special precautions are taken to guard against it.

It is usual to place a large trap in the main house-drain a short distance outside of the cellar-wall. The object of this is to keep the air of the street-sewer from entering the drain-pipes within the house. But a trap in the main drain obstructs the outward flow of sewage to such an extent as to cause accumulations of filth to collect, which may produce a condition of affairs in the house-drain considerably worse than that existing in the sewer. In ordinary cases it will be safer to omit the trap, and allow the air of the sewer to flow through the main soil-pipe and out at the top above the roof. But there are important exceptions to this general rule. A trap should always be used between a cess-pool and the house draining into it. And when sewers have a slight inclination, with a sluggish flow through them, so that they are unusually foul, it will be better to have traps put into the connecting house-drains. Whenever these traps are used, there must be an inlet provided for the admission of a copious supply of fresh air to the drain-pipes between the trap and the house, and as near to the former as possible. This will cause an almost constant upward flow of air through the main channel of the house drainage system, giving free ventilation to places where impurities may collect.

Space will not allow a more extended consideration of matters of detail. The design and execution of our systems of house-drainage should always be intrusted to some competent sanitary authority, in place of being left to the hap-hazard direction of careless architects and ignorant plumbers. The importance of obtaining absolute security where so much inherent danger exists can not be overestimated. With all the advantages derived from a constant and sure development of the science of sanitation, our houses may be made safe against the entrance of sewer-air. The perils arising from ignorance and neglect are easily eliminated. And, above all, a determined effort should be made to arouse public opinion, so that it shall demand the repeal of objectionable municipal ordinances framed in the interest of corrupt politicians and mercenary tradesmen.

GOURDS AND BOTTLES.

By GRANT ALLEN.

STROLLING, this afternoon, down the street El-Akhdar, where silent Arab women, muffled up to the eyes, gliding noiselessly past, disappeared at my approach, to right and left, down darkling doorways in the narrow alley, I chanced to pass the Moorish shop of my friend the Hadji Omar-ben-Marabet, who, removing his pipe gravely from his mouth for a moment, beckoned me in with his hand to the court-yard of his house to bespeak my favorable inspection of his new stock of rustic, hand-made Kabyle pottery. I followed him through the corridor to the open *oust,* or central hall, and proceeded to look over his latest importations. The Hadji's wares were indeed pretty and curious enough, manufactured in quaint traditional shapes from the coarse yellow clay of the country by the deft-fingered women of the Djurjura Mountains. Two among them took my fancy especially. One was a flattened circular vase or bottle, with a short neck, and two handles at the side, covered with a pretty running arabesque pattern of the kind so common on the Morocco earthenware. The other was a quaint little red gourd-shaped vessel, with two bulges, constricted in the middle, exactly like the ordinary shepherd's gourd that one sees so often hanging from a countryman's girdle on the Roman Campagna or the Provençal hill-sides. After the usual chaffering and higgling of the market, conducted on both sides with unabated ardor for several minutes, my good friend Hadji Omar consented at last to accept for the pair—from me only, he called Allah to witness, as a particular customer—one third of the price he had at first demanded; and I walked off in triumph, at the end of our debate, with my two jars slung proudly in my hand, and my purse lighter by probably not much more than double the real value of my two little purchases. Now, at the wine-shop next door, where a Barbary Jew, in dark-blue turban, jacket, and sash, administers drink, in spite of the Prophet's veto, to thirsty humanity, all and sundry, be it Christian or Moslem, there hung at the lintel a whole string of gourds —the natural fruit, look you, not any spurious fictile imitation— which interested me strangely, because they happened to belong to two separate varieties, the originals and models, as chance would have it, of my two curious Kabyle vases. Struck by the resemblance, I bought one of each, to complete my little illustrative museum of native pottery; and I have them now set up in the horseshoe arch by the window before my eyes as I write, a perpetual reminder of the true origin of all the bottles known

either to barbarous or civilized people. For even that familiar brown glass receptacle out of which we pour Bass's beer at our modern dinner-tables, derives its shape ultimately from the Mediterranean gourd; and every other form of bottle in the known world is equally based, in the last resort, upon some member or other of the gourd family.

I don't believe, indeed, the importance of gourds, as a class, in the history of civilization has ever yet been properly recognized by the annalists of culture. On them, it would seem, with their close congeners the tropical calabashes, the entire art and mystery of pottery ultimately depend. It is possible to trace back almost every vase or other fictile vessel manufactured to-day at Burslem or at Vallauris to this most primitive and simple of all possible water-jars. It behooves us, therefore, in an epoch of pot-hunters, to know something of the nature of this earliest pot, as a moment in the evolution of our existing civilization. A plant on which so ancient and universal an art at last bases itself may well claim some twenty minutes of our scanty leisure in this æsthetic, refined, and pottery-worshiping century.

The gourd, then, to begin at the beginning, is of course a cucumber by family, belonging to the same great group of rapidly growing and large-leaved climbers as the melon, the pumpkin, and the vegetable marrow. All these plants are mere annuals, and they are remarkable among their class for the stature they attain in a single year, for the size of their leaves, and for the bigness of the fruit, in comparison with the short time it takes in growing. Only the sunflower and Indian corn can equal them at all in this last respect. Vegetative energy is the strong point of the gourds. They have a power of growth and a vigor of constitution nowhere surpassed among yearling plants. It was not without reason in the nature of things that the creeper which grew up in a night and overshadowed Jonah should have been figured by the Hebrew allegory as a gourd. No other plant grows so fast, or produces in so short a space of time so luxuriant a canopy of shady foliage.

The true gourds, in fact, have adapted themselves entirely to the climbing habit. This is in itself a half-parasitic mode of existence to which many plants have taken as a bid for life, because it saves them all the trouble and expense of producing a stout and woody stem for their own support. The way the gourds climb is by means of spiral, curled tendrils, which are in reality small abortive stipules or leaf-appendages, specialized for the work of clinging to the external object, be it bough or stem of some other plant, over which the beautiful parasite rapidly spreads itself. The tendrils push themselves out on every side, revolving as they go, till they reach some slender twig or leaf-stalk to which they

can attach themselves. It is curious and interesting to watch them as they grow, and to see how closely their movements simulate intelligent action. The little curled whorls go feeling about on every side for a suitable foothold, groping blindly, as it were, in search of a support, and revolving slowly in wide-sweeping curves, until at last they happen to lay hold with their growing end of a proper object. Once found, they seem to seize it eagerly with their little fingers (for in the gourd the tendrils are branched, not simple), and to wrap it round at once many times over in their tight embrace. It is wonderful how far they will go up out of their way in their groping quest of a proper foothold, and how, when at length they stumble upon it, they will look for all the world as if they had known beforehand exactly when and where to search for it. These actions come far closer to intelligence than most people imagine; they are deliberately performed in responsive answer to external stimuli, and only take place when the right conditions combine to excite them.

Your young gourd, then, once it grows from the seed, begins from the very first to look about for a neighboring bush up which it may climb to reach the sun and air that it could never get at on the ground beneath, or approach by its own unaided efforts. In this respect it is one of the most advanced and highly developed members of its own family. Its humbler ally, the squirting cucumber of the Mediterranean shores (a quaint little creature about which I shall have more to say hereafter), remains to this day a mere lowly trailer, unprovided with tendrils or other means of climbing, and therefore necessarily confined to open, waste places, where alone it can hope to procure its fair share of air and sunlight. In the true cucumber, on the other hand, and the bryony of our English hedges and waysides, there are climbing tendrils, but they are simple and unbranched. In the gourd itself, however, a plant of Indian origin, accustomed to the rough, wild scrub of the tropics, the tendrils are forked, so as to aid the plant in climbing rapidly over the thick and tangled vegetation of its native jungles. The ample leaves then spread themselves out broadly in the full sunshine, mantling their unwilling host with their luscious green, and choking it slowly out by shutting off from its foliage all the life-giving rays and carbon-laden air.

All annuals flower as soon as they have laid by sufficient material for producing their blossoms. The flowers of the gourds, however, like those of their allies the melons and cucumbers, present one very curious peculiarity. In all these plants, the sexes are distinct; and, in most of them, the male and female flowers are borne on totally different plants. The reason for this arrangement is no doubt to be found in the common necessity for cross-

fertilization. And this is how the gourd and cucumber have solved that great *crux* of plant organization:

The male flowers are larger than the female, and consist simply of a funnel-shaped corolla, inclosing a column of yellow stamens. They have no fruit or ovary in the center, nor even the abortive rudiment of such an organ. The female flowers, on the other hand, have no stamens, but the corolla caps a small round berry, the parent or embryo of the future fruit. Its center gives rise to a slender style, forked and feathered at the tip, which is the sensitive surface of the unswollen ovary. Now, when the bee or other fertilizing insect visits a male flower, he dusts himself all over (unconsciously, of course) with the fertilizing pollen. If, on flying away, he next visits another male blossom on the same plant, he only collects still more pollen. But if he happens to flit off to a female flower, he brushes off some of the pollen, as he passes, on to the feathery, sensitive surface protruded by the plant right in his path, on purpose to meet him. In this way, each female blossom makes perfectly certain of due fertilization from a separate organism; and such cross-fertilization, as Darwin has shown, produces in the long run the most fertile seeds, and the strongest, heartiest, and most vigorous seedlings.

Originally, there can be little doubt, the flowers of the gourd family were all hermaphrodite, as those of many among their less developed relations still remain to the present day. But, once upon a time, certain progressive gourds happened accidentally to acquire the habit of producing more or less abortive stamens on certain blossoms; and as these gourds would therefore almost necessarily insure cross-fertilization, and so produce in the long run the finest seedlings, the habit once accidentally set up would be carefully fostered by natural selection, till it grew at last into a confirmed practice of the entire race. All through nature, indeed, we find that the scrubbiest, weediest, and shabbiest species still retain the primitive habit of self-fertilization or in-and-in breeding; but that all the chief places in the hierarchy of life are filled by species which have acquired in one way or another the salutary practice of cross-fertilization, and which thus encourage to the utmost of their power the frequent introduction of fresh blood. The gourds, as a very dominant race, have naturally conformed to the general practice of higher types in this respect; and gardeners find, when they exclude insects from their hot-houses and cucumber-frames, that they have to come to the aid of Nature by artificial means, and to fertilize the blossoms with a camel's-hair pencil.

The flowers of the melon, the cucumber, and the vegetable marrow are bright yellow and almost, if not quite, scentless. Those of the true gourd, on the other hand, with which we are

here chiefly concerned, are white and perfumed. Now, nothing in nature is without a reason; and this change of color in the gourd kind from the ordinary normal hue of its race at large is not without a sufficient purpose either. I don't know whether most people have ever noticed that bell-shaped or tubular white flowers are almost always heavily scented. Examples familiar to everybody occur in the jasmine, the stephanotis, the gardenia, the tuberose, and the large white tobacco so much cultivated of late in garden-borders. It often happens, indeed, that a plant possesses two allied varieties, one of them blue, pink, or yellow, and scentless, while the other is white and deeply perfumed. In these cases, the first kind is a day-flowering plant, while the second opens and spreads abroad its scent in the dusk of evening. One well-known instance exists in England: the red campion or day-flowering lychnis is pink, scentless, and strictly diurnal; while its ally, the white campion, is beautifully perfumed, and opens its flowers at the sunset only. The reason is that the one species is fertilized by day-flying bees or butterflies, and the other by crepuscular or night-flying moths. Now, in the gray dusk no color can so readily be distinguished as pure white; and lest this peculiarity alone should prove insufficient to attract moths to the patch of light among the dark foliage, the added attraction of perfume is thrown in gratis by moth-fertilized plants. Such night-flowering white blossoms never possess the spots or lines or colored marks on the petals, which serve as honey-guides in other plants to lead the bees straight to the laden nectary. In the twilight, variegation or dappling of that sort would be wholly useless.

The blossoms of the gourds, then, are fertilized by moths, attracted to the plant at nightfall by the white corolla and the rich, heavy perfume of the bell-shaped flowers. This perfume is one of a type much affected by æsthetic moths, and not unpleasant to ourselves in the open air, but too cloying for a room, as is the case also with the kindred scent of stephanotis and tuberose. As soon as the flowers have been all fertilized, the male blossoms wither away to nothing; but the small berry underneath the female ones begins to swell out into a big, round fruit with surprising rapidity. Great heat and much sunshine are of course needed in order to produce this startling result with an annual plant; and hence the gourd family consists mostly of luxuriant tropical or subtropical species. Their center of origin would seem to lie in India, where species and individuals are still most numerous. Thence the gourds have spread, with gradual modifications to suit climatic changes, to all the hotter climates of the Old and New Worlds. Some of them have reached as far as Peru and the Cape of Good Hope. But very few of them have spread far northward, because a northern climate is ill-adapted for such large and rap-

idly growing tropical plants. The best known North American example, in the north and east at least, is the pretty little "prickly cucumber," so commonly used in New England and the Middle States as a climbing plant for arbors and trellis-work. A single species alone reaches England, the familiar bryony; and, in this case, the necessary modifications and dwarfing of parts to meet the circumstances of a cold climate are at once apparent. The plant has been forced to become a perennial, and store by nutriment for coming years in its thick and poisonous roots; for the short and treacherous English summer would not suffice for it to bring its fruit to maturity in the first season. The berry has also been fined down from its tropical dimensions to about the size of a haricot-bean, in accordance with the needs of English fruit-eating birds, for a reason which we shall fully examine a little later. If one compares these two tiny northern gourds with the great tropical calabashes, often six feet long and eighteen inches round, one will see at once the amount of degradation undergone by the gourd kind on its northward progress, in adaptation to the needs of a chillier climate.

All the gourd-like fruits are the same in ground-plan, familiar to everybody in cross-section in the case of the unripe cucumber as it appears at the dinner-table. There are always the same three or five rows of flattened seeds, immersed in soft pulp, and surrounded by the fruit with its harder skin, often brilliantly colored with red or yellow. But infinite variations of shape and size are permitted in every direction upon this single original central plan. Nature runs riot in modifications of detail. In order to understand them, we must remember that the gourds, as a family, are berry-bearing plants, dependent in most cases for the dispersion of their seeds on the friendly offices of birds or animals. It is to meet the varying views and tastes of these their animate friends and allies that the different hues, coverings, and pulps of the diverse sorts have all been adopted.

We shall see this better if we look at the one early member of the gourd family which does not seek to attract animals to devour its fruit—the squirting cucumber—and observe the many conspicuous points in which it broadly differs from all its congeners. The squirting cucumber is a scrubby Mediterranean trailer, known to all the world at Nice and Cannes, bearing a long, hairy, and almost prickly fruit, which remains green even when ripe, and is bitter, fetid, and sickening to the senses in all stages. It derives its common name from its curious habit of breaking off short whenever touched, and jumping away from the parent stem, as if alive, while at the same time it squirts out all its seeds, with the surrounding pulp, into its aggressor's face, through the opening left by the broken stem. The squirting cucumber, in short,

if I may venture so to describe it, is the skunk among vegetables. Its object in life, its sole aim and desire, is to deter animals from eating its fruit and seeds; and therefore it makes itself as unpleasant and as inconspicuous as it possibly can. It is green, so that animals may not readily detect its presence among its leaves; it is spine-clad, so that they may not attack it with their tender noses; it is nasty to the taste and disagreeable to the smell, so that they may avoid its neighborhood when once they have learned to know its personal peculiarities. If a goat or a donkey, wandering among the scrub, chances to touch the long, trailing branches, the cucumber squirts out its juice in his eyes, and at the same time sows its seeds all round on a spot where no hostile creature is likely to interfere with them. We have here in a very extreme form a specimen of that rare type of succulent fruit which does not lay itself out at all to attract the attention of friendly animals, but, on the contrary, endeavors energetically to repel them.

The mass of the gourd-kind, however, pursue the exactly opposite tactics. They have learned by experience to imitate rather a policy of conciliation, and to turn the birds, quadrupeds, and fruit-eating animals generally in their environment from deadly foes into friendly disseminators. For this purpose, their fruits, when ripe and fit for seeding, become red, yellow, pink, or orange, though they only assume these brilliant hues at the exact moment when the seeds are ready to be severed from the parent stem and dispersed for germination. Till that time, they remain green and sour, or at least tasteless. The seeds in these cases are surrounded by a soft, sweet pulp, especially noticeable in the melon and the watermelon; and this pulp the plant gives in, so to speak, as an inducement to animals to disseminate its seeds over the surrounding country. It has learned organically the value of rotation of crops. It desires fresh soil in which to expand. The actual seeds themselves, however, are not sweet; they are inclosed in a hard and somewhat horny or leathery shell; and they are seldom eaten and still seldomer digested by birds or animals, owing to their tough and slippery surfaces. We have here, then, the very same inducements of food, sweetness, perfume, and color expended by the plant upon its fruit for the sake of its seeds that we saw before expended upon the flower for the sake of obtaining cross-fertilization by the aid of insects.

At the same time, it is interesting to note that almost all the gourd family possess in some part or other of their economy certain bitter, nauseating, medicinal principles, expressly intended to deter animals from meddling with or eating them. But these bitter principles are variously distributed in the leaves, stems, stock, or fruit, according to the special type of dangers to which the par-

ticular plant is specially exposed. The red berries of our English bryony are eaten by birds, who aid, of course, in disseminating the seeds; but the big and swollen root, known to French herbalists as the *navet du diable,* in which the plant stores all its accumulated material for next year's growth, is strenuously protected from the attacks of rabbits, pigs, and other grubbing animals by an intensely bitter and poisonous principle which chemists call bryonine. Colocynth, again—the amorous colocynth—is a plant closely allied to the melon and cucumber; but in this case the intensely bitter and poisonous essence (the "uncompounded pills" of the poet) is diffused in the fruit itself, which, like that of the squirting cucumber, desires to repel rather than to entice the attentions of animals. In the edible cucumber, once more, which prefers to be eaten, the bitter principle is collected at the stalk-end of the unripe fruit, as well as generally in the outer rind, thus serving to prevent attacks in the early stages of growth, or unauthorized grubbing into the soft pulp by useless insects. I suppose I need hardly remind even the non-agricultural mind in these days of villa-gardening that the ripe cucumber is bright yellow, smooth, and faintly sweetish; on our tables it always appears in its unripe stage, when it is green, hard, and covered externally with rough excrescences, intended to repel the attacks of enemies. In the early gherkin state it is even prickly.

The fruit of the actual bottle-gourd itself is intermediate in size between the great tropical calabash and the little bryony-berries of our northern hedge-rows. Its one noteworthy peculiarity lies in its hard, coriaceous, and shining rind, far more woody in character than even that of its near allies the pumpkins and the calabashes. This peculiarity, again, is not without a meaning in the history of the race: it points back with no uncertain finger (why should gourds be denied fingers?) to the subtropical origin of the gourd species. For the bottle-gourd itself, to employ the language most frequently applied to our Aryan brother, is a native of India, though it has long been cultivated for the sake of its fruits round the whole Mediterranean. Now, it is a noticeable fact in the philosophy of fruits that most fruits of northern climates, like the strawberry, raspberry, blackberry, and currant, can be picked off the bush, tree, or vine, and popped at once into the mouth without any preparation; but almost all tropical fruits, like the orange, pineapple, mango, and banana, require a plate with a knife and fork to eat them with; in other words, they can only be eaten after we have stripped off a hard or nauseous rind.

Why this difference? Well, it has reference clearly to the kind of animals by which the seeds of each are oftenest disseminated in the native condition. Northern fruits, in short, are mainly eaten by small birds, which swallow them whole, but

never digest the hard, knobby seeds, so conspicuous in the blackberry, the currant, and the grape. Southern fruits, on the contrary, are mainly eaten by parrots, monkeys, and other large fruit-feeders, for whose attraction the plants specially lay themselves out. Hence the southern types desire to keep off unauthorized small intruders, which would merely pick holes in their pulp without doing any real good to the plant, as wasps do with our northern peaches. For this purpose, natural selection has favored in their case the development of various abstruse devices for keeping off the smaller birds and animals. Sometimes, as with the orange, lemon, and citron, the outer rind is bitter and nasty; sometimes, as with the cashew, it is violently pungent, acrid, and irritating; sometimes, as with the pomegranate, it is merely hard, stiff, and leathery. But, in all instances alike, it is meant to repel by every means in the plant's power the small intruder. Monkeys and parrots, however, the friends of the species, do not mind these slight outer defenses; they strip them off easily with hand or beak, and reach the sweet pulp within, duly intended by the grateful tree for their edification. On the other hand, the actual seed itself in tropical fruits is always thoroughly well protected against their teeth or bills, either by a very hard stone, as in the olive, date, and mango, or by intense bitterness, as in the orange and lemon.

It is to this specially defended tropical type of fruits that the true bottle-gourd essentially belongs. Our little English bryony has a mere northern bird-berry, round, and red, and soft, and almost rindless; it has adapted itself in this matter to the small ways of robins and finches. But the gourd has a hard and forbidding rind; it fastens itself up in a firm covering; it lays itself out with all its soul for the larger fruit-eaters of tropical forests. Not, indeed, that in its raw ripe state the gourd is by any means so dry and hard as in the arid form which we see in southern wine-shops. The method of preparing gourds for use as bottles is, indeed, a sufficiently lengthy one. You pick your fruit and hang it up to dry, not in the sun, but under the shade of the roof, for a whole year before it is fit for boring. As soon as it has hardened evenly all over, you cut a round hole at the stalk-end (at least in the common double-bulging form employed as a flask by southern shepherds) and rattle out the dry seeds and pulp, which easily come out of themselves through the opening. The remaining husk is hard enough and thick enough to bear carving. I have several gourds in my little collection thus carved in deep relief with Moorish patterns, including one which bears on its face, four times repeated, a text from the Koran.

Gourds, calabashes, and the shells of cocoanuts, together with human skulls and the horns of cattle, sheep, and antelopes, seem

to have formed the earliest natural objects employed as vessels by primitive humanity. But of all these the gourd, by its singular variety of shape, best lent itself to the greatest and most varied uses. Besides the common double-bulging form, constricted in the middle, with the little bulb above and the big one below, so frequent as a water-bottle, you can get gourds in an immense number of other types, globular, compressed, bowl-like, or flask-shaped. A Corsican model, which lies before me this moment as I write, has a flattened circular form from back to front, the back being the side next the stalk, and the front the side where the corolla has fallen off, leaving a little umbilicus or knob to mark its place in the very center. This form is ingeniously turned by the Corsicans into a very neat sort of flask or bottle for the girdle by cutting holes in the narrow side and fastening two handles for suspension at a graceful point half-way between the mouth and the middle line of the circle. The pretty vessel thus obtained is the model on which thousands of exquisite vases have long been turned out in ancient Etruria and at modern Vallauris.

The commonest shape of all, however, is the Syrian gourd with a round bulb, ending toward the stalk in a long neck, and capable, when filled with wine or water, of standing securely on its own basis by means of the slight depression at the umbilicus. This is, indeed, the original parent from which almost all bottles, *carafes*, and decanters, all the world over, have ultimately descended. The terra-cotta forms used as water-bottles, with a round bulb and long neck, most closely resemble their original to the present day, as the Japanese vases of two or three bulbs, successively constricted and growing larger from top to bottom, most closely resemble the double-bulging variety.

The reason why gourds are so manifold in shape is twofold. It is partly because they are a naturally plastic species, constantly giving rise to various divergent forms, like their neighbors the cucumbers; which divergent forms have, of course, been seized upon and still further developed for his own use by gourd-using man. But it is partly, also, because gourds, while growing, can be made to assume almost any desired shape or curve by tying string or wire round their rind. Primitive man early discovered this simple method of manufacture. I have seen gourds which in this manner have been twisted into the semblance of powder-horns or wallets, and others which have been induced to ring themselves round half a dozen times over till they look almost like beads on a necklace.

Early man, no doubt, used his gourd as a gourd alone. But as time went on he began at last, apparently, to employ it as a model for pottery also. In all probability his earliest lessons in the fictile art were purely accidental. It is a common trick with savages to

put water to warm on the camp-fire in a calabash or gourd with wet clay smeared over the bottom to keep it from burning. Wherever the clay thus employed was fine enough to form a mold and bake hard in shape, it would cling to the gourd, and be used time and again in the same way without renewal, till at last it came to be regarded almost as a component part of the compound vessel. Traces of this stage in the evolution of pottery still exist in various outlying corners of the world. Savages have been noted who smear their dishes with clay; and bowls may be found in various museums which still contain more or less intact the relics of the natural object on which they were modeled. In one case the thing imbedded in the clay bowl is a human skull, presumably an enemy's.

In most cases, however, the inner gourd or calabash, in proportion as it was well coated up to the very top with a good protective layer of clay, would tend to get burned out by the heat of the fire in the course of time; until at last the idea would arise that the natural form was nothing more than a mere mold or model, and that the earthenware dish which grew up around it was the substantive vessel. As soon as this stage of pot-making was arrived at, the process of firing would become deliberate, instead of accidental, and the vessel would only be considered complete as soon as it had been subjected to a great heat which would effectually burn out the gourd or calabash imbedded in the center. But the close similarity of early fictile forms all the world over, and their obvious likeness to the same simple, natural types, combine to show us that the art of pottery had everywhere the same easy origin, and that it was everywhere based on the same primitive unmanufactured vessels.

Three main forms of pottery, and later of glass-ware, may be safely held to take their origin from the bottle-gourd alone. The first is the double or treble-bulbed vase, so common a type in Japanese and Oriental pottery. This is the most distinctively gourd-like of all, and it has given rise indirectly to endless variations. The second is the flat, circular vase with two lateral handles—the *diota*—always showing in early specimens its gourd origin by the nature of its ornamentation, which radiates (as is well exhibited by some of my Morocco specimens) from the umbilicus or calyx-scar in the center of the fruit. The third is the clay water-bottle or *carafe*, with round bulb below and tall neck above, which gives rise in turn to the vast majority of modern vases, vessels, and bottles. Even the common beer-bottle, with the "kink" or "kirck" at the bottom, affiliates itself ultimately upon this last-named form, being derived in the last resort from those long-necked gourds which could stand firmly on their own basis, owing to a slight re-entrant depression about the umbilicus. The bowl or basin, on the other

hand, owes its shape rather to the gourd or calabash cut in two transversely, and used as an open receptacle for liquids and powders. Of such bowls I have one or two excellent savage specimens. To this type may at last be traced, I believe, the tea-cup, the coffee-cup, the mug, and perhaps also the tumbler.

I may add that, in simple and early types of pottery, the ornamentation is always based on the natural forms suggested by the first or other primitive model. The decorations were first copied, I believe, from the ornamentation carved or worked on the natural form, except where they arose from the marks of thongs or other suspenders used in the firing. Now, in the gourd we have, so to speak, three natural elements of ornamentation to which all decorative adjuncts, if any, must necessarily adapt themselves: First, there is the stalk cut off to form the mouth in my first and third types, but retained as a central scar or knob, the main focus of the whole, in the second or diotic form so common in Corsica; secondly, there is what I have ventured here to call the umbilicus —the mark left by the faded calyx and corolla in the center of the fruit, retained as a central point of the vessel in all three forms; and, thirdly, there are the lines in the grain of the gourd which radiate like meridians from either pole, running from the stem-scar right round the equator to the umbilicus. Whoever tries to decorate a real gourd, either by carving or painting, will find himself practically compelled to fall in with the natural lines thus inevitably laid down for him; he must obey the laws of his prime material. All gourds actually decorated, however rudely, in simple and *naïve* societies are so adorned. Hence, in the first and third forms, the decoration runs up and down the sides of the bottle, or in transverse bars and longitudinal lines; while in the second or flat, circular vase type it runs always in concentric rings round a point in the middle.

Now, this pretty Kabyle ware, which formed the original text for my present sermon, is pottery of a very antique and *naïve* type—the last relic, in fact, of ancient Phœnician art. The Phœnicians brought these ideas with them to Carthage, and the Crathaginians diffused them among the aboriginal mountaineers of the Atlas range, whose lineal descendants are the Kabyles of the Djurjura in our own day. That simple ware, with its yellow groundwork and its dichromatic ornamentation in russet-brown and black (the one ochre, the other peroxide of manganese), has been manufactured ever since in the uplands of the Atlas by the Moslemized grandsons of the Christianized Mauritanians. In tone and color it recalls somewhat the earliest Greek and Etruscan vases: but the law of Islam, of course, prevents the introduction of human or animal figures, so the ornamentation now consists entirely of geometrical and arabesque designs, accommodated to

the necessary natural lines of their gourd originals. Each village has its own distinctive patterns. I have a small collection of native Kabyle and Morocco pottery, and in every piece without exception one can see at once the particular sort of gourd—double, single, or flat-faced—on which each individual vase must be finally affiliated. And, when once one has learned to know and recognize these central types, the character of the ornamentation on more advanced keramic products of other nations often enables one to guess correctly from what original natural form the particular piece in question is ultimately descended. I believe it would be possible so to arrange all the keramic products in a great museum, along a series of divergent radial lines from certain fixed centers, that the common origin of all from each special sort of gourd or calabash would become immediately obvious to the most casual observer.

DARWINISM AND THE CHRISTIAN FAITH.

III.

WE come now to that which most people feel to be the real difficulty in the way of accepting Darwinism. No well-instructed churchman supposes that the faith of Christ stands or falls with the theory of special creations, or that the existence of God is less certain because we have learned that the witness of conscience is necessary to interpret the witness of Nature, and that physical science by itself can tell us less than we thought about the personality and the love of God.

4. But Darwinism means a great deal more than the substitution of derivation for special creation, or of the new teleology for the old argument from design. It means a new view of man, and his place in creation. Darwin foresaw this from the first, and in the "Origin of Species" asserted his belief that "much light will be thrown on the origin of man and his history."* Now, if this had only meant a chemical analysis of "the dust of the ground" out of which man was formed, if, like Matthew Henry, Darwin had assured us—on grounds for which, indeed, no evidence is given—that the dust was "not gold dust, powder of pearl, diamond dust, but common dust: dust of the ground"; "not dry dust, but dust wetted with the mist which went up from the earth," it is clear religion would have felt that it had lost as little as science would have gained. But Darwin's theory connected man with the higher *vertebrata* by analogies as strong as those which made other species descendants from a common stock. This was the secret of the opposition to the "Origin of Species."

* P. 428.

It was not so much what was stated, as the obvious implications of the doctrine, which men shrank from. Darwin, who had nothing of the defiant arrogance of some who speak in his name, was even accused of dishonesty in not clearly stating at the outset the bearing of the doctrine on man. And his volume on "The Descent of Man" was his answer to the charge. But his letters show how fully he realized the consequences of his theory from the first:

> I am deeply convinced [he wrote to Lyell, while revising the proof-sheets of the "Origin"] that it is absolutely necessary to go the whole vast length, or stick to the creation of each separate species.* . . . I can see no possible means of drawing the line and saying, Here you must stop.† . . . I believe man is in the same predicament with other animals. It is, in fact, impossible to doubt it.‡

For the scientific acceptance of the theory, as Darwin says, "*ce n'est que le premier pas qui coûte,*"# but for people generally, who judge a theory by its consequences, not on its evidence, it is, as he says of Carpenter, "the last mouthful that chokes." ‖ Of course, as he admits, it is open to every one to believe that man appeared by a separate miracle,^ but to hold the doctrine of special creation here and here only is to ignore the arguments which, *ex hypothesi*, carried conviction everywhere else.

It was on this point that Darwin and Wallace parted company, though the divergence is commonly represented as far greater than it was. Wallace admitted the evolution of man out of a lower form, but contends, and this was what he calls his "heresy," that natural selection would have only given man a brain a little superior to that of an ape, whereas it is greatly superior. He therefore contrasts "man" with the "unaided productions" of Nature, and argues that, as in artificial selection, man supervenes and uses the law of natural selection to produce a desired result, so "a higher intelligence" may have supervened, and used the law of natural selection to produce man. Whether from the scientific side this is rightly called a "heresy" or not it is not necessary to decide; but certainly, from the religious side, it has a strangely unorthodox look. If, as a Christian believes, the "higher intelligence" who used these laws for the creation of man was the same God who worked in and by these same laws in creating the lower forms of life, Mr. Wallace's distinction, as a distinction of cause, disappears; and if it was not the same God, we contradict the first article of the Creed. Whatever be the line which Christianity draws between man and the rest of the visible creation, it certainly does not claim man as the work of God, and leave the rest to "unaided Nature."

We have then to face the question, If it be true that man, "as

* "Life and Letters," i, p. 519. † i, p. 526. ‡ ii, p. 59.
# [It is only the first step that costs.] ii, p. 30. ‖ ii, p. 35. ^ ii, p. 58.

far as his corporeal frame is concerned,"* is created, as other species were, by evolution from lower forms; if he was not, as we have been accustomed to think, an independent creation, but related through his whole bodily structure with "the beasts that perish"; if he was not an absolutely new departure, but the last term in a progressive series—how does this new view affect our Christian faith?

We might have been ready to answer, It no more touches the Christian view of human nature than a scientific proof, if it had been possible, that our blessed Lord was very man would affect the truth of his divinity. And the analogy is a very close one. It is not heresy to assert that Christ is Ἄνθρωπος, but that he is ψιλὸς ἄνθρωπος, man and nothing more. Similarly, say what we will of the affinities of man's physical nature, it is only when we deny that he is anything more that we really degrade him. As Bacon somewhere puts it—

> They that deny a God destroy man's nobility; for certainly man is of kin to the beasts by his body; and if he be not of kin to God by his spirit, he is an ignoble creature.

Unfortunately, Christian apologists have missed an important distinction. They have not seen that their controversy with a Darwinian agnostic is a controversy with his agnosticism, not with his Darwinism; with his limitation of all knowledge to the facts of sense, not with any doctrine he may scientifically prove as to the interrelations of the facts observed.

We are constantly told that Darwinism is degrading, that it is unworthy of the dignity of man, that it is a "gospel of dirt." If such a charge had come from a representative of those nations which held the descent of man from gods or demigods, it would have been intelligible enough, but it sounds strange in the mouth of those who believe that "the Lord God formed man of the dust of the ground." Indeed, what in Darwinism is called a "gospel of dirt," appears in the Bible as a "gospel of grace." We naturally, as Kingsley says, seek—

> To set up some "dignity of human nature," some innate superiority to the animals, on which we may pride ourselves as our own possession, and not return thanks with fear and trembling for it as the special gift of Almighty God.†

But the inspired writers "revel in self-depreciation" that they may the more exalt the love and condescension of God. The moral, as distinct from the scientific, teaching of the Bible can not be mistaken in this matter. Man made in the image of God, inbreathed with the breath of life, is formed of the dust of the ground. God's method is always to choose "the base things of the world and things which are despised," and use them for his

* Darwin, ii, p. 140.

† "Prose Idylls," p. 22.

purposes. The chosen people traced their descent from "a Syrian ready to perish." They were the "fewest of all people," and constantly reminded of their origin. "Remember that thou wast a bond-servant." "Look unto the rocks whence ye are hewn, and to the hole of the pit whence ye are digged." And yet they were what they were, the destined repository of the oracles of God, and the religious teachers of the world. The Bible at least gives no color to a view which refuses a degraded origin for man.

But Darwinism, dealing with man, as it is bound to do, simply from the side of his animal and corporeal nature, has done something to give man his true place in the physical universe. It has, by the application of its own methods and its own tests, recognized him as the roof and crown of all things visible. And by so doing it has rendered any form of Nature-worship henceforth impossible. The highest, or the least degrading of these, was the worship of the sun. When Anaxagoras ventured the speculation that the great god Helios was a mass of molten metal, he was condemned as a heretic. Science has trodden in his footsteps, and we know now that the sun is a very large ball of solid and gaseous matter, in a state of fierce incandescence, and supported by involuntary contributions. It has been "found out," as completely as the Boxley rood, when people were shown its works—

> No man [as the Duke of Argyll says] can worship a ball of fire, however big; nor can he feel grateful to it, nor love it, nor adore it, even though its beams be to him the very light of life. Neither in it, nor in the mere physical forces of which it is the center, can we see anything approaching to the rank and dignity of even the humblest human heart.*

Nor can we any longer worship organic Nature. For we are ourselves, if Darwinism is true, the last term in the series. If man must have a visible god, he must henceforth worship himself or something lower. In Genesis he is made lord of the visible world, to have dominion over the fish of the sea, and the fowl of the air, and every living thing that moveth upon the earth. What Genesis speaks of as the will of God, Darwinism reads in Nature as a fact:

> Man [says Darwin] in the rudest state in which he now exists is the most dominant animal that has ever appeared on this earth. He has spread more widely than any other highly organized form, and all others have yielded before him.†

It is not true, then, that Darwinism degrades man, for in tracing his descent it chronicles his rise from the lowest origin to the highest order of being of which science has any knowledge.

And what about the soul? If man, in his animal nature, was evolved from lower creatures, when did God "breathe into his

* "Unity of Nature," p. 309.

† "Descent of Man," p. 48.

nostrils the breath of life"? Was the soul, too, created by evolution, or was that at least a "special creation"? We are here, be it observed, going beyond the range of our subject, which was the relation of Darwinism to the Christian faith, and passing into a region where neither science nor religion has spoken. Dr. Pusey says "theology does not hold transformist theories excluded by Holy Scripture, so that they spare the soul of man." But science spares the soul of man, just as it spares original creation, because it can not have any knowledge of either. It can deny both. What is there that man can not deny? It may even cover its dogmatic denial by a semblance of reason with the help of the major premise: "What science can not know can not be known." From this, no doubt, the conclusion follows with logical necessity. But we answer with *negatur maior.* With regard, however, to the question of the origin of the soul, as a theological problem, it is perhaps easier to say what is not true than what is. The soul can not be a "special" creation whether in Adam or in his children. There is no "species" of soul. We may call it, if we will, an "individual" creation; but is not all creation individual creation from the religious point of view? And if so, it is a phrase which does not help us.

We can, however, *explain* the difficulty in precisely the same way in which science explains a law—namely, "by substituting one mystery for another."* We may say that there is no actual or conceivable difficulty in the creation of the soul of Adam which does not recur in the case of every child born into the world. Is its soul inherited, like its bodily organism, or is it added to the body? The instincts of Christianity, rather than any formal decision, have throughout been against traducianism, or the inheritance of the soul. Creationism, or the *infusio animæ,* on the other hand, guards a truth which traducianism loses. But in spite of all the authority which can be claimed for it, it sounds crude and strange, to our ways of thinking. The very word *infusio,* and, in a lesser degree, the barbarous word "insufflation," suggest that the soul is a *thing* which at a definite though unknown moment is put into the body "like a passenger in a boat," as Aristotle has it. If so, the body before the advent of the soul was not in any real sense human. For "the reasonable soul" is as essential to true humanity as the "flesh." And if the analogy suggested in the Athanasian Creed justifies us in appealing to that greater mystery, on which Christian thought, in defense of the faith, has been compelled to speculate and define, we have to remember that it is heresy to assert that "that Holy Thing," which in the fullness of time was to be born of the Vir-

* Mill, "Logic," i, p. 527.

gin, *became* at any moment the Word of God. In the history of the individual, so far as his physical structure is concerned, science can trace each step from the microscopic cellular germ to the fully developed man. If we believe that man as man is an immortal soul, though we can not say when he became so, or that, strictly speaking, he ever did *become* so, we need not be surprised to meet the difficulty again in the evolution of man from lower forms.*

In both cases man is what he is, whatever he came from. We do not say a man is not rich because we have found out how he made his fortune. We do not say the eye can not see because we can trace it back to a speck of pigment sensitive to light. Whether God formed man literally "from the dust of the ground," or raised him by progressive selection to what he is; whether, in scientific language, man rose to manhood "by the final arbitrament of the battle for life"; † or whether, as Mr. Wallace thinks, there is a certain amount of "unearned increment" to be accounted for, man is still man, "the glory and the scandal of the universe." Darwin, feeling "the extreme difficulty, or rather impossibility," of conceiving the universe as not being the work of "a First Cause having an intelligent mind in some degree analogous to that of man," ‡ is driven back into agnosticism by the question, "Can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such grand conclusions?" # Yet when Darwin, in all the wealth of his scientific experience, and all the strength of his disciplined reason, gives us his matured judgment on the processes of Nature, who would dream of saying, "How can I trust the conclusions of a man who was once a baby"? We trust him for what he *is*, and not for what he *was*. And man is man, whatever he came from. And what is man?—

> "Distinguished link in being's endless chain!
> Midway from nothing to the Deity!
> A beam ethereal sullied and absorpt!
> Though sullied and dishonored, still divine!
> Dim miniature of greatness absolute!
> An heir of glory! a frail child of dust!
> Helpless immortal! insect infinite!
> A worm! a God!" ‖

What a piece of work is man [says Hamlet]. In action, how like an angel; in apprehension how like a god! the beauty of the world! the paragon of animals! And yet, to me, what is this quintessence of dust? △

Man is a part of Nature [it has been said], and no artificial definitions can separate him from it. And yet in another sense it is true that man is above Nature—

* Cf. "Origin," p. 412. † "Descent of Man," p. 48. ‡ "Life and Letters," i, p. 282.
# Ibid. ‖ "Night Thoughts," i. △ Act ii, scene ii.

outside of it; and in this aspect he is the very type and image of the supernatural.*

By Nature we understand all visible things, including man so far as he can be observed by the naked eye or the microscope—his morphology, his physiology, his histological development. But for a Christian this does not exhaust human nature. For him visible Nature is the segment of a circle, "we see but in part." And the visible is not coextensive with the known. Rather the ultimate explanation of "the things which are seen" is to be sought in "the things which are not seen." There are forces which refuse to be measured by "foot-pounds," facts which forever must escape the microscope, realities which cast no bands upon the spectrum field, a life which the scalpel can neither discover nor destroy. A Christian believes with Mr. Darwin "that man in the distant future will be a far more perfect creature than he now is," and finds it "an intolerable thought that he and all other sentient beings are doomed to complete annihilation after such long-continued slow progress"; † but he holds it in a different way and on different grounds. And, believing in the truth of man's divine nature, he can watch without anxiety, not without interest and gratitude, the work of those who are showing us man's place in the physical world. Darwin tells us that, as he lay on the grass on an April morning at Moor Park, amid the joy of opening spring-tide, he "did not care one penny how any of the beasts or birds had been formed." ‡ Amid the supreme realities of the moral and spiritual world, or in the devotional study of the Word of God, it becomes a matter of relative unimportance to a Christian whether he is to trace his pedigree back directly or indirectly to the dust. For it is God's world after all. We believe in the resurrection of the body as well as the immortality of the soul. That which is material is not "common or unclean":

> What we are [says Kingsley], we are by the grace of God. . . . Saint Francis called the birds his brothers. Whether he was correct, either theologically or zoölogically, he was plainly free from that fear of being mistaken for an ape, which haunts so many in these modern times. Perfectly sure that he himself was a spiritual being, he thought it at least possible that birds might be spiritual beings likewise, incarnate like himself in mortal flesh; and saw no degradation to the dignity of human nature in claiming kindred lovingly with creatures so beautiful, so wonderful, who (as he fancied in his old-fashioned way) praised God in the forest, even as angels did in heaven.#

With regard to all this higher side of man's nature, Mr. Darwin was an agnostic. He uses the word more than once of himself, and yet, with that transparent honesty which characterizes all that he did, he admits the difficulty as well as the unsatisfactoriness

* "Unity of Nature," p. 308. † i, p. 282. ‡ i, p. 471. # "Prose Idylls," pp. 24, 25.

of his position. There was a time when men dared to say that because the presence of sin veils the knowledge of God, therefore they who do not accept Christianity in a Christian country must be guilty of secret, if not open, sin. That phase, thank God, has passed. And then—that men might have a theory—they talked of intellectual pride. Intellectual pride, which is self-assertion, no doubt obscures the vision of God. It is as much a rejection of God as a sinful life is. But dare any one say that loss of faith or the inability to receive it must spring from one of these two causes—immorality or intellectual pride? We believe it is impossible to read Darwin's "Life and Letters" without noticing as the most striking characteristics of Darwin's mind his intense modesty, his self-forgetfulness, his shrinking from popularity or applause, while gladly welcoming the testimony of those who were competent to judge of the truth of his work, his devotion to truth as shown by the weight he gave to unfavorable facts, his humility, his simplicity, his reverence. How could such a lovable nature, we are tempted to ask, have rejected Christianity? or, to put it differently, how could Christianity have failed to make good its appeal to such a nature as this?

In the whole record there is nothing so intensely interesting as Darwin's account of his religious opinions and the steps by which he became an agnostic. What was his religious history? His mother was a Unitarian, his father he describes as "a free-thinker in religious matters," though nominally belonging to the Church of England. Darwin himself was christened and was meant to belong to the Church, but he was sent to a day-school kept by the Unitarian minister. His mother attended the Unitarian chapel and took her sons with her. She died when he was eight years old, and after that he seems to have gone to church, and later on we hear of his intention of "going into the Church" * —an intention which was not abandoned till the Beagle voyage. His view of the ministry is incidentally given in a letter from Lima in 1835: "To a person fit to take the office the life of a clergyman is a type of all that is respectable and happy." † During all this period he "had not thought much about the existence of a personal God." ‡ He had read Paley, but had taken Paley's premises "on trust," # so that even his Unitarianism, which, as he tells us, his grandfather spoke of as "a feather-bed for a falling Christian," was hardly enough to break the fall. Under such conditions we are not surprised to hear that the intention to be a clergyman "died a natural death." ‖ That idea abandoned, the two props on which his religion rested—Paley's "Natural Theology" and Pearson "On the Creed"—gradually gave way. The Paleyan argument disappeared with the abandonment of special

* i, p. 146. † i, p. 234. ‡ i, p. 278. # i, p. 41. ‖ i, p. 39.

creation; the Old Testament, from which Pearson started, seemed "no more to be trusted than the sacred books of the Hindoos."* "Disbelief crept over me at a very slow rate, but was at last complete. The rate was so slow that I felt no distress."† One of his difficulties is worth noticing as showing how little he had brought religious truth under that great conception of growth which dominated all his physical inquiries. It seemed to him "incredible" that, if God were now to make a revelation to the Hindoos, he would permit it to be connected with the belief in Vishnu, Siva, etc., as Christianity is connected with the Old Testament. Why? except for the very reason that makes it "incredible" that man should be evolved directly from a fish, and not "incredible" that he should be evolved from the higher vertebrates. He has organic relations with both, but these relations are not such as to make it indifferent from which he is derived.

It was not religion alone, however, that "died a natural death" in Darwin's case. It is almost pathetic to read his account of the way in which he fell out of correspondence with poetry and painting. Up to thirty or beyond he delighted in both. Gradually they ceased to interest him, and finally they became positively distasteful:

> I can not endure to read a line of poetry: I have tried lately to read Shakespeare, and found it so intolerably dull that it nauseated me. I have almost lost my taste for pictures or music. . . . My mind seems to have become a kind of machine for grinding general laws out of large collections of facts. But why this should have caused the atrophy of that part of the brain alone on which the higher tastes depend, I can not conceive. . . . If I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once a week; for perhaps the parts of my brain now atrophied would thus have been kept active through use.‡ . . . It is an accursed evil to a man [he writes to Hooker in 1858] to become so absorbed in any subject as I am in mine.#

We shall not, we trust, be accused either of want of sympathy or want of charity, if, in the light of what Darwin has told us of his religious history, we sum it up in the words *the atrophy of faith.* That which Bacon sets first among the "Idola Specûs," the tendency to draw everything round to the predominant pursuit, shows itself in as many forms as there are absorbing studies. A theologian or moralist rarely appreciates the strength of scientific evidence: a scientific man underrates the value of moral and spiritual forces. It is unfortunately always easy to discredit or ignore facts which are not *in pari materiâ* with those which lie nearest to our heart, or to offer, in terms of our own special study, an explanation which only explains the facts away. So the theologian will pooh-pooh scientific discoveries which do not readily and at once fall under his own categories of thought; and the sci-

* i, p. 277. † i, p. 278. ‡ i, pp. 81, 82. # i, p. 495.

entific specialist will blandly put aside religion, because he can not without trouble relate it with what he can touch and taste and handle. To relate truths which belong to different orders plainly requires a greater effort than to relate those which belong to the same. Yet if the effort be not made, the predominant study may still advance, but at a real, perhaps a fatal, cost. The atrophy of faith is commoner than atrophy elsewhere. For men have come to think that while they must devote a lifetime to science, or philosophy, or art, or literature, they can pick up their religion as they go. And the result is, that religion becomes like a tender exotic in their lives, and in their struggle for existence "the thorns spring up and choke it." Agnosticism is often an *ex post facto,* though honest, justification in theory for a religious atrophy which has already taken place in fact, just as men deceive themselves and appeal to "other-worldliness" to cover the neglect of daily duties. Christianity makes faith the Christian's *work.* It knows no short cut to spiritual truth, only the royal road of individual search and personal effort. But there are agnostics like Darwin, and there are agnostics whose agnosticism is a thin disguise for plump self-satisfaction. There are evolutionists like Darwin, who can not see their way to Christ; there are also evolutionists like the great American botanist, just dead, who speaks of himself as—

> One who is scientifically, and in his own fashion, a Darwinian, philosophically a convinced theist, and religiously an accepter of the "Creed commonly called the Nicene" as the expression of the Christian faith.

POSTSCRIPT.

Among the many difficulties which in the preceding articles we have not touched, there are two which will probably be present to the minds of many. Without attempting to discuss them, we may state them, and suggest the lines on which, as it seems to us, they should be dealt with.

1. It may be said, "Then you are prepared to give up Genesis?" To which it may be answered, "*Yes,*" if by "giving up Genesis" you mean refusing to claim for it what it never claims for itself—that it is a prophetic anticipation of nineteenth-century science, and a revealed short cut to Darwinism. We can not sympathize with those "reconcilers" who would read between the lines of the Mosaic history a meaning which, if had been stated in plain words, would have put an infinitely greater strain on the faith of those for whom it was written than even its verbal accuracy would put on ours in the present day.

2. Then, it may be asked, "How about the fall? Is that an allegory, or a metaphorical name for a step forward in evolution?" We answer briefly: The fall implies a change, and a

change for the worse, in the relation of man as "a living soul" to his Creator—God. Positive science—and Darwinism is in every way bound by the limits of positive science—will neither help nor hinder us in discussing the relation between two terms, both of which are outside its range.

In a word, we are as little prepared to consult Genesis on the order of the paleontological series as to ask the high-priests of modern science to solve for us the difficulties of our moral and spiritual life.—*The Guardian.*

THE TEACHING OF PSYCHOLOGY.

By M. PAUL JANET.

IN giving the name of Experimental and Comparative Psychology to the chair into which it has transformed its ancient chair of the Law of Nature and of Nations, the College of France has sought to give it a title broad and comprehensive enough to accommodate itself to all contingencies. To have called it physiological psychology would have made physiology too prominent, and the chair might then eventually have become a mere annex of that science. Physiologists have done much, but they have not done everything, for experimental psychology. An intelligent magistrate who has thoroughly studied the moral and mental state of criminals; a philosopher versed in ethnological or in animal psychology; a pedagogue who has observed human faculties from an educational point of view; a pure psychologist, acquainted to the bottom with all parts of the science, but capable of including them in a single philosophical synthesis—might all compete for such a chair, which would not then be the exclusive domain of any one specialty. The real name for this science would be objective psychology, if that term were not too pedantic for common use. There are, in fact, two psychologies: one which is constructed by the inner sense, and is the basis of the other, which might be called subjective psychology; and the other formed by outward observation, by the study of other men and of animals, or of the nervous system, which is the objective psychology of which we are speaking. The second psychology has always existed to a greater or less extent; but it is something new to treat it in and for itself, disengaged from the other, and to constitute it an independent science. One among the different parts of which it is composed seems to be more advanced than the others, and more nearly ready to claim to be a positive science. It is physiological psychology, or the science that studies the organic and physiological conditions of the mental faculties; and it

is in its turn divided into two parts, accordingly as it studies the sound man or the diseased man. The former is physiological psychology properly called, the other pathological psychology. This distinction is, however, more ideal than real, because so far the whole study has proceeded rather by the pathological road than by the direct observation of the healthy condition; but it is, nevertheless, correct in principle.

The matter of the new science comprises a number of facts not yet connected or co-ordinated, but which have been determined, to a certain extent. Among them are cerebral localizations, aphasia in particular, the muscular sense, heredity, suggestion, double consciousness, etc., besides others which have been longer known.

The theory of cerebral localizations was suggested by Dr. Gall and the phrenological school, who, however, compromised it by associating it with an untenable system, for which they did not offer a shadow of positive proof. Flourens approached the subject in a scientific manner, with experiments on the brains of pigeons, from which he deduced that the brain participates in the functions of thought and feeling as a single whole. He nevertheless opened the way to localizations by distinguishing various organs in the brain, and employing the distinctions of the spiritual philosophy between sensation and thought, seating the latter in the brain and the former in the spinal marrow. The theory of localizations has become much more precise since Flourens. Not only has it been possible to seat the motor functions and their various disorders with a quite novel precision in their several parts of the brain and spinal cord, but the mental faculties also have begun to yield to efforts to localize them. Thus, the faculties of pure thought have been placed in the gray matter, and the plurality of the cerebral organs and the diversity of their functions appear to have been established in the surest and most brilliant manner in the theory of the seats of language, in which the faculties relating to speech, reading, writing, and hearing are severally assigned their specific quarters. In this we have one of the clearest and most precise of the data of psycho-physiological science. The object of this science is the determination of the physiological or organic conditions of the mental faculties. In the present case the mental faculty is language; the plurality of seats is the organic condition; and this plurality explains the singular separations that are made in certain morbid cases between groups of phenomena absolutely homogeneous, as, for example, between reading and writing. Yet it is doubtful if we can go on to say that this explains language itself in so far as it is a psychological faculty. It is a case of cerebral topography and correlation, but nothing more.

One of the most obscure and complicated questions of physio-

logical psychology is the theory of the muscular sense. Destutt de Tracy maintained that without motion we could not have knowledge of the existence of bodies; for it is arrested movement that gives the sensation of resistance. The essential point in the theory is to distinguish the sense of effort from purely passive muscular sensations. If consciousness is a good judge in these matters, says Alexander Bain, we may say that in voluntary effort we have the feeling of a faculty experienced from within outward and not that of a sensible surface stimulated by an external agent and transmitting an impression from without to within the nervous centers. The sense of effort would then seem to be the feeling of the production of motion rather than of motion produced. It is anterior and not posterior to the motion. Without going into detail, we can, according to Bain, refer all muscular sensations to two great classes: the sensation of tension, and that of motion. Tension is an act of effort in so far as it meets an invincible resistance, for example when it endeavors to raise a weight that is beyond its strength, or to stop a galloping horse. We can distinguish three distinct sensations in that of tension: pressure, traction, and weight. The first occurs when we wish to crush an object, as a nut, with the hands; the second, when we wish to lead an object, as a horse, or a man who is resisting us; and the third, when we lift a weight. The first is an effort of ourselves on the exterior object; the second, of the exterior object on us; and the third, an upward effort. The feeling of tension is the same, whether the extensor or flexor muscles are involved. It is in a certain manner the feeling of force in equilibrium with the exterior force, but at its limit, and unable to go farther.

It is surprising that Bain, in discussing what he called the sensation of motion, did not first ask if such a sensation exists. Without doubt, since we effect motion, there must be something in the consciousness that corresponds to it; but does that something resemble what we call a motion—that is, a displacement in space? We see that the question of the sensation of motion is closely bound with the idea of the perception of space, or with the most obscure and complex question of metaphysics. Without this notion of space, the muscular sensation could not even take the name of tension or of contraction, for these terms imply motion, and motion implies space. The only peculiar characteristic of muscular sensation appears to be fatigue. Effort is an internal fatigue distinct from the external fatigue which is imposed by causes foreign to us. It consists in giving one's self a fatigue by the production of a desired act. We thus see how apparently the most elementary questions are complicated with those of the highest order. What, for example, is a desired act? The study of the simplest sensation, therefore, involves a theory of the will.

One of the most delicate questions of the theory of muscular sensations is that of defining tactual sensations. Having abstracted from touch all that relates to the sense of effort, what is left to constitute touch proper? Sensations of temperature, and what we call sensations of contact. But can there be sensations of contact without there being more or less of pressure, traction, etc.? Is simple contact felt, otherwise than as heat or cold, when we abstract all muscular sensation? Might we not simply revert from it, as did Biran, to the distinction between passive touch and active touch, the latter including the effort? But there appear to be pathological cases where the touch persists while the muscular sense is abolished, as, for example, where the patient with his eyes closed can not tell where his limbs are, whether his arm is raised up or lying down, etc.; but these cases relate to the localization of sensations, another of the most complex questions, and to that of the perception of our body, which is no less so.

There is left the physiological question proper, that of the seat of muscular sensation, on which there are two theories. According to what is called the centrifugal theory, the feeling of muscular effort is connected with the outgoing current of the motor influx. According to the other, the centripetal theory, it is produced by the sensations returning from the member in motion to the centers. Both of these theories find points of support in experiments made upon hysteric patients, who have in these days become veritable analytical machines for the use of psychology. On the one side are hysterics who, having lost the muscular sense, and shut their eyes, have no knowledge of the passive movements that are impressed on their limbs; and yet this loss of muscular sense takes away none of the precision of the motions which the subject executes; an observation which is interpreted by some authors as favoring the centrifugal theory; because, centripetal sensations being abolished with these patients, there must exist some condition of consciousness regulating their movements, and that condition of consciousness can be determined only by the outgoing current of the motor influx. There are, on the contrary, other hysterics who, losing consciousness of the passive movements, lose also that of active motions, and become incapable of executing a single act with shut eyes, which is interpreted as meaning that voluntary motions are impossible when centripetal sensations are abolished. This interpretation would indicate that there exists no feeling allied with the motor discharge and competent to regulate motions in the absence of centripetal sensations. It is apparent that physiology has yet very far to go before it can pretend to have solved these questions. But, as facts, the experiments in question are very interesting; and it happens

very frequently in the experimental sciences that we possess facts without being able to connect them by theories.

According to Kant's law, all our sensations are intensive quantities; that is, they are matters of degree. Can we, then, apply precise mathematical measures to their intensity? Every sensation does, in fact, present itself to us as being more or less strong, and consequently as a magnitude. Then why can we not measure it, like any other magnitude or any quantity? But we must mark a difference between psychological or physiological measures and the physical measures of physicists. As physics measures sounds, light, and heat, it might appear that we should already have been able to measure sensations. But it is obvious that physics measures these qualities only as objective properties of bodies, while the psychological measure of sensations is a quite other question. The present question, for example, is whether two quantities of light, physically and objectively equal, produce equal sensations, and unequal luminous causes produce unequal sensations—or whether, in short, the proportion existing between the causes also exists between the effects. "There is no one," says M. Ribot, "who has not compared two sensations and remarked that one is stronger and the other weaker. We declare without hesitation that there is more light at noonday than in moonlight, and that a cannon-shot makes more noise than a pistol." So far consciousness is sufficient; but this is not what we call measurement from the mathematical point of view. To measure a magnitude mathematically is to find how many times it is contained in another magnitude taken as unity. Has the sun a hundred or a thousand times more light than the moon? Does the cannon make a hundred or a thousand times more noise than the pistol? Such questions can not be answered by the consciousness, which can not tell us how many times one sensation is contained in another. It would naturally occur to the mind that sensation increases in proportion to the excitation, as when Herbart thought that two lights would give twice as much illumination as one. But this is not true. We hear distinctly sounds in the night, or in solitude, which are imperceptible in the daytime or in the hurly-burly of business. A double volume of sound is not produced when the number of instruments or of singers at a concert is doubled. A question is involved, calling for careful discussion in determining the proportion in which sensation is augmented or diminished with the excitation. This is one of the objects of what is called psycho-physics.

The question of heredity is another of the new matters which physiological psychology has introduced into philosophy. Till recently, the factor of heredity has been omitted in psychological treatises. In the schools of Condillac, Reid, and Jouffroy, the in-

dividual was considered as an absolute whole, sufficient in himself, and having no roots in the past. But the theory might almost be established *a priori*, for it is certain that heredity plays a part in the physical man. Every one recognizes the existence of hereditary diseases and the resemblance of children to parents. It is also generally acknowledged that the physical exercises a certain influence over the moral; it follows, therefore, that what is transmitted by the physical may be communicated, in a certain measure, to the moral. Yet much precaution is needed in the interpretation of these facts, for the law of heredity has to compete with another psychological law, that of imitation or of contagion by madness, the delusion, and the same delusion, is communicated to another by contagion and not by heredity. Undoubtedly, if the case is one of mother and daughter, it might be maintained that heredity plays a part; but, in the case of two sisters, there example. It is necessary, therefore, in discussing the facts on which the thesis of psychological heredity is supported, to select those with which it is possible to disengage these two elements from one another.

The fact of hypnotic suggestion, which has been so much talked of recently that it has nearly become wearisome, is nevertheless one of the most certain and best established facts. It causes astonishment solely by the extraordinary consequences which have been seen to be produced by it; for, at bottom, it was not unknown. It is a familiar fact that there can always be more or less of communication, in normal sleep, between the sleeper and the persons around him. No one is surprised, for example, that when music is performed in the presence of a person who sleeps through it without waking, he will say on waking that during his sleep he attended a concert of angels. The sensation has been entangled with the sleep, and has suggested by association a series of images which have a relation to it. It is known, also, that we can, in some cases, act upon the sleeping man, and obtain responses by speaking, or excite and direct his dreams by some other mark. This elementary fact, exaggerated and developed in certain organizations, and in particular diseases, especially in hysteria, has become the extraordinary fact of suggestion with all its consequences. It is not impossible to find its origin in the normal state. If we tell an infant that the murmuring wind is the voice of a weeper, or that a pale reflection of moonlight is a ghost, it will hear voices and see ghosts. The same fact, in hypnotism and hysteria, produces surprising phenomena. Movements, sensations, and more or less complex acts may be suggested to the hypnotized patient. Illusory sensations, and consequently hallucinations, can also be provoked. Like effects can be obtained without a real object, and by virtue of speaking alone, or

even by the simple association of ideas. Suggestion can even be brought to bear upon purely physical phenomena, as, for example, paralysis. We speak now of subjective burnings, of suggested blisters; and possibly the strange phenomena of stigmatics may have their origin in something of the kind. The suggestions of acts are the most important in this category, because they are what most cause somnambulists to resemble wakeful men, while passing from the domain of sleep into that of waking. They provoke the grave question of responsibility. Suggestions of this kind can be relegated to three groups: suggestions made during sleep of acts to be accomplished during sleep; suggestions made during sleep of acts to be accomplished during the wakeful condition; and suggestions during the wakeful condition of acts to be accomplished while awake. Here suggestion appears in its most wonderful manifestations; for examples are cited of suggestions enduring three months of incubation. Nothing is, without doubt, easier than to suppose a simulation under such circumstances; and our professors of hypnotism do not make efforts enough to invent counter-proofs and traps against imposture. But the number of facts bearing upon the matter is so considerable, and they are verified by so many examples, that a universal deception would be as hard to understand as the fact itself.

We can give only a bare outline of the facts here and will merely add that the question of suggestion raises many others; among them that of the relation of hypnotism to hysteria; that of hypnotic phases (lethargy, catalepsy, and somnambulism), which are affirmed at Paris and denied at Nancy; that of the passage from the normal to the suggestive state, and *vice versa;* the philosophical questions that are more or less involved in the discussion, such as those of free-will and responsibility, and the question of double personality.

The fact of sleep may of itself have already suggested the idea of two distinct persons, for we certainly are not the same sleeping and waking. Yet, in sleep, we have recollections from the waking state, and we can remember from sleep when awake. There is, therefore, an essential connection between the two states. There are in natural somnambulism at the same time more and less of analogy with the wakeful condition. In one respect it more resembles wakefulness; for while, in natural sleep, the dream is absolutely incoherent, the somnambulist plays out his dreams; that is, he executes a system of co-ordinated movements having a beginning, a middle, and an end, or a certain coherence. On the other hand, somnambulism is further separated from wakefulness in the fact that the man awake wholly loses the recollection of what the sleeping man has done, while the somnambulist can remember what he has done in a previous sleep. There are, then, in

some fashion, two lives, and the hypothesis dreamed of by Pascal is very near to being realized: "If we dreamed every night the same things, it would affect us as much as objects that we see every day; and if an artisan were sure to dream during the twelve hours of every night that he was a king, I believe that he would be almost as happy as a king who should dream for twelve hours that he was an artisan." Pascal speaks here only of dreaming, but it must not be forgotten that somnambulism is composed both of dream and reality. The somnambulist performs actions that take place in the real world; he walks, he writes, he does nearly everything that he does while awake, and is even able to speak and reply. Hence we have only to represent to ourselves somnambulism gaining more and more upon the waking condition, encroaching upon it, and at last becoming a second waking alternating with the other, and retaining only one feature of somnambulism—the loss of recollection on waking. Take the case of Felida, the celebrated subject on whom this double personality was observed for the first time. She (who I believe is still living) has two succeeding and alternating existences, in each of which she has a different character and different trains of thought; but above all remains the characteristic fact that, in the part of her life that corresponds with the former normal condition (for we can now hardly detect a difference between the two states), she does not recollect from her other existence, while in the latter she often remembers from the former. From this we have the expressions secondary condition applied to the second waking, and primary condition applied to the first waking, or original normal state. There are then two selves superposed in a fashion and alternating with one another. If at any moment the memory should disappear from the former state, the rupture would be absolute, and we should be in the situation imagined by Leibnitz*: "If we could suppose that two separate, distinct, and incommunicable consciousnesses were acting by turns in the same body, the one during the day and the other during the night, I ask if, in such a case, the man of the day and the man of the night would not be two persons as distinct as Socrates and Plato?"

To the phenomena of succession, are added those of simultaneous doubling of the personality. M. Taine cites an example of this in his work on "Intelligence," from the observations of Dr. Krishaben. A patient had lost the consciousness of his own existence, and had afterward reached the feeling that he was some other one than himself. "It seemed to me," he said, speaking of his first state, "that I was no longer of this world, that I no longer existed; but I had not then the feeling of being another." Of the

* The hypothesis is really not by Leibnitz, but by Locke, and Leibnitz has only reproduced it in his "Nouveaux Essais."

second state: "I felt myself so completely changed that I seemed to have become another being. This thought imposed itself upon me without my forgetting for an instant that it was illusory." We once saw, in the asylum of Stephansfeld, near Strasburg, a patient who was in the first state and had not yet reached the second, or who had perhaps passed it and had no longer strength enough to believe himself other than himself, for, according to his fancy, he had died in the night. He said to us: "You are very happy, you other people; you have a *me*, I have no longer a *me*." He did not even perceive the contradiction, and then we reminded him that he was living, and existed as much as we did. "No," he said, "it is the external powers that sustain me and cause me to live, but not myself." The poor fellow felt that life was escaping him and held only by a thread, that it was hung to some external condition, and expressed the thought in metaphysical terms, having probably made some studies in philosophy; he had at last exteriorized his consciousness, and was very near being some one else than himself. An example occurs in Gratiolet of a patient who imagined that he was in two beds at the same time. In cases of suicidal mania, it is not rare to see the subject doubling himself and hearing voices commanding him to kill himself. He resists; he replies, making the objection and the response at the same time, but he does not believe that it is himself doing both. This is what happens also in spiritualism and in the case of writing or speaking mediums. But in all the preceding cases we perceive that, of the two personalities, one is illusory. A case is presented of optical illusion of the consciousness as there is an optical illusion of the senses; a false interpretation of the phenomena of consciousness, which refutes itself. In the recent experiments in provoked somnambulism, however, we have come to the point of separating distinctly two consciousnesses, one of which seems to be as real as the other. A person converses with you while he is writing a letter, or making a complicated calculation, one of the two personalities not knowing what the other is doing, but each being aware of what itself is doing. This is the most advanced and at the same time the most obscure point of the question.*

These are the principal facts with which psycho-physiological science occupies itself. There are many others which it would be tedious to recite; the law of association between ideas and motions, the unconscious motions, the theory of which M. Chevreul began in his work on turning tables; the theory of physiognomy, of which Duchesne de Boulogne has established the physiological basis, and from which Gratiolet and Darwin have drawn psychological results; researches on memory, the theory of hallucination, and

* See the remarkable experiments of M. Pierre Janet, Professor of Philosophy at Havre; "Revue Philosophique," December, 1886; May, 1887; and March, 1888.

the whole domain of mental pathology. Here is a vast field for study for which we are better equipped to-day than ever. There is certainly in it the material for a science, and consequently the basis for a system of instruction. Yet suspicions and scruples, explainable but exaggerated, have been raised against these new studies. It will be well to point them out and estimate them in order to fix, as far as possible, the principles of the question.

It is remarked, first, that physiological psychology is not yet a made and established science. It is, they allege, only a confused mass of doubtful facts and arbitrary opinions; only a collection of hypotheses that have no authority at all in science, and therefore no right to be taught. I admit that there is much in physiological psychology that is conjectural and arbitrary, and that there is too much haste to rush to conclusions and doctrine; but the assertion that there are no certain facts in it, nor a certain number of positive laws, or at least of legitimate researches, appears to me to be refuted by the preceding summary. There is, therefore, a science in a nascent state, a science in the course of formation. The question now is, whether such a science ought to be taught. Instead of seeing an objection in the transitory condition of the science, I see in it only an additional reason for teaching it. The nascent science is the one that needs to be taught. There was great reason for creating in the Faculty of Sciences the chair of Microbiology, although that science was only born yesterday, and changes from day to day to such an extent that the professor may often find himself between one day and another in the presence of unexpected facts that will constrain him to modify his previous assertions. But there was all the greater need of such a chair; for where could any one desiring to occupy himself with this science, and to work for its further progress, prepare himself for it? So with psycho-physiology. Suppose a young philosopher or physiologist, attracted by studies of this character, and wishing to devote himself to them; where could he learn the elements of this science? They are scattered in thousands of volumes of philosophy and medicine, where they are mingled with everything else. Only to examine these books is an infinite task. Add that they are not always easy to get, that no one has them all in his library, and that most of them are written in foreign languages; and, further, that frequently the most important facts are not in special books, but in the memoirs of academies, in the collections of scientific societies, and in scattered pamphlets; and all this without connection, unity, or method. How can any one acquaint himself with it without a guide, without a leading thread? The object of the new chair is to furnish such a guide. Teaching is, therefore, the precise thing necessary to bring the science out of the nascent state.

A more formidable apprehension is the one that there will slip in, under the name of physiological psychology, not a science, but a doctrine, and this—to call things by their right names—the materialistic doctrine. This objection should be examined to the bottom; it is important to have it removed, not only in the interests of sound thought, but also in those of the science which is concerned. Nothing could be more fatal to the future of this science than to give it a materialistic significance.

In principle, psycho-physiological science is neither materialistic nor spiritualistic. It is, or ought to be, exclusively experimental and scientific. Its disinterested character in this respect is proved by the fact, which has not been sufficiently insisted on, that it was founded by men of spiritual belief: the spiritualist Descartes; after him the mystic Malebranche; and, succeeding them, Charles Bonnet, of Geneva, the most religious man of the eighteenth century. Among contemporary German psychologists, as named by M. Ribot, are Lotze, an avowed believer in spirit, who has revived Leibnitzianism in Germany; Helmholtz, the great physicist, is a Kantian, as also is Wundt, the chief of the school, who declares that physiology can account for the inferior but not for the superior faculties of the human mind; Fechner, the discoverer of the law that bears his name, is an illuminate far more spiritual than materialistic; and Weber is a pure physicist, indifferent as between metaphysical schools. Thus, not one of the most authoritative masters of the new science in Germany is a materialist. The same can not be said of all the physiologists who are occupied with these questions; but the science itself is indifferent as between the two doctrines, and can associate itself with either. Yet, to be just, and not to hold to appearances only, it is clear that a science which occupies itself with the physiological conditions of thought, or with the part played by matter in the operations of the mind, will always have a color of materialism. If Descartes had only written the first part of the "Treatise on the Passions," in what could this treatise be distinguished from Lamettrie's "Homme-Machine"? Suppose, now, that in consequence of the multiplication of objects of study, and through the division of labor, an author should limit his studies to the first order of researches, without adding the corrective, as Descartes did in the third part of the "Passions," should that make him pass as a materialist? Certainly not. All that we can ask of him is to leave such questions open.

A second right that can not be denied to psycho-physiology is that of establishing and affirming facts, whether or not they be agreeable to this or that doctrine. For example, the fact of hypnotic suggestion recently brought to light has a frightful appearance to many minds, who believe that it involves the overthrow of

moral and social order. The fear is exaggerated and chimerical; but that is not the point to be considered. A fact is always a fact, whatever may be the consequences. The question is, whether it is true; the student should recognize no other. Many of the facts encountered in our studies are obscure and hard to explain, but that does not prevent their being facts; or at least the chief question should be, to learn whether they are facts. Besides, contradictory facts are the ferment of science. I once asked a distinguished man of science how a certain discovery he had made was getting on. "It is not getting on," he replied. "What is the matter with it?" I anxiously asked. "Why," he said, "I find no facts except those which are favorable to it; and," he added, "it takes contradictory facts to teach us." This is true. The theory will either explain the contradictory facts and be fortified by them, as the Newtonian theory has been by all the exceptions that have been opposed to it and which have entered into it; or it will be replaced by a wider and more comprehensive theory. In both cases there is a gain for science, which would not have been obtained if we had hesitated, on account of vain scruples, to seek out and verify the facts in question. In principle, every science should be independent of those which come after it. Chemistry, for example, whether organic or physiological, in studying the chemical conditions of life, is held to one thing only—to seek out and discover those chemical conditions—and has no other function. It is not for it to occupy itself with the interests of vital force nor with anything that concerns the vital. Its right and duty are to push as far forward as possible the chemical explanation, for who else is to do it? Then comes the physiologist. His business is to bring into the light the new element which has been added to the former. Chemistry could have been preoccupied with this only to its detriment. If chemistry had been concerned to take care of the existence of the vital principle, it would not have achieved the splendid discovery of organic synthesis which has made the name of M. Berthelot illustrious. Does this signify that life is not a chemical fact? Not at all. But it belongs to physiology, and not to chemistry, to exhibit the peculiar quality that distinguishes the one science from the other.

Applying these principles to psycho-physiology, all the clouds that obscure the question are dispelled. The function of psycho-physiology is not to establish the existence of the soul; that belongs to pure psychology and metaphysics. How can we expect to find the soul, personality, freedom, in the study of the organs? The interests of the soul would therefore be very badly placed in the hands of psycho-physiology. They are better confided to other hands; and in touching upon these higher questions, that branch would be doing an injury to the cause which it assumed to serve.

Flourens thought he had found a triumphant argument against materialism when he concluded that the brain was a simple and not a multiple organ, the unity of the brain appearing to him to be the proof and the security of the unity of the self. If his argument had been sound, the spiritual doctrine would to-day have been condemned by its own acknowledgment, for it now seems certain that the brain is not a simple but a composite organ.

This kind of independence is generally conceded to all the other sciences which are recognized and have had a long existence. Thus, we do not require political economy to establish the principle of duty, or history to prove the existence of a Providence. There is or there is not a Providence; but the historian knows nothing about it. There is or there is not a principle of duty; but the economist, as an economist, has no cognizance of it. We often even regard as culpable doctrines which make morals intervene in political economy, such as the socialist doctrines which aim to impose devotion and fraternity upon economical transactions. We admit that the law of competition is cruel, but we do not wish as economists to introduce a law of charity to correct it. That is a matter of morals, not of political economy. It is by observing such precise distinctions that political economy has succeeded in constituting itself as a science. This independence is useful not to political economy only, but to morals as well, which has no interest in seeing its peculiar principle confounded with the peculiar principle of the former science, which is mere utility.

The same is the case with history as related to theodicy. Surely, if there is a Providence, it should manifest itself in the series of human events. But no historian of the present, not even the most pious and most Christian, would think of bringing the name and action of God into his history. We explain all historical events by second and profane causes, often also by material or geographical conditions, as when the whole history of England is accounted for by the fact that it is an island. The intervention of gross passions is brought in; sometimes fortuitous encounters or physical needs are invoked; as when the invasions of the barbarians are accounted for by the necessity of their finding food. No historian would say to-day, in a book on the "origins" of France, that God urged the barbarians on, as Salvien did in his "De Gubernatione Dei." One might have religious scruples against pronouncing the name of God in the minor events of history; against saying, for example, that God desired that the Abbé Dubois should be nominated a cardinal, or that Du Barry should enter the bedchamber of the king. What would such a historian reply to a critic who should object to him: "You never pronounce the name of God; you never speak of Providence; your science is

atheistic"? The historians of the present time would be astonished at such an objection. But it is of the same kind as that which is made when physiological psychology is reproached with not speaking of the soul, of freedom, and of personality, and with only recognizing the physical conditions of phenomena, although that is the only problem which it pretends to resolve.

As a rule, all the sciences that study the conditions necessary to a higher development can be called, in a qualified way, materialistic with reference to the higher sciences. They are certainly so in the sense conceived by Aristotle, to whom matter was only the basis on which was built and to which was added a new form; and it is still a question in metaphysics whether there is any other matter than that. In the Aristotelian sense, chemistry is materialistic in relation to physiology; physiology in relation to psychology; political economy in relation to morality; geography in relation to history, and history in relation to theodicy. Psychophysiology thus appears to be in the same condition as the other sciences. In itself it is less materialistic than physiology proper, because it adds an element, consciousness, which physiology does not recognize; but it is more materialistic than psychology proper, which studies consciousness itself and in itself.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

CUSTOMS AND ARTS OF THE KWAKIOOL.*

By GEORGE M. DAWSON, D. S., F. G. S.

DURING the summer of 1885, the writer was engaged in the geological examination of the northern part of Vancouver Island and its vicinity, the territory of the Kwakiool people. In connection with the prosecution of his work, he was in constant and intimate association with this people, and enjoyed many excellent opportunities of obtaining facts respecting them, of hearing their traditions and stories, and of becoming familiar with their mode of life and habits of thought. The notes, made at the time, are here presented in a systematized form. As thus set down in order, they are intended to be merely a record of facts and observations, and are offered as a contribution toward our knowledge of the Indians of the west coast. Notwithstanding diversity of language and dialect, these coast people form a single group in respect to arts, and to a less extent in regard to customs and traditions. The useful arts and modes of construction have

* Abridged from a paper entitled "Notes and Observations on the Kwakiool People of Vancouver Island," presented to the Royal Society of Canada, May 25, 1887.

evidently been readily adopted by various tribes from whatever source they may have originated. In dexterity and constructive skill, as well as in artistic representation, the Haida people, however, excel all the others.

The villages consist usually of a single row of houses ranged along the edge of the beach and facing the sea. The houses are generally large, and are used as dwelling-places by two or more families, each occupying a corner, which is closed in by temporary partitions of split cedar planks, six or eight feet in height, or by a screen of cloth on one or two sides. Each family has, as a rule, its own fire, with cedar planks laid down near it to sit and sleep on. When, however, they are gathered in the houses of smaller and ruder construction, at summer fishing-places, etc., a single fire may serve for a whole household. The household effects and property of the inmates are piled up round the walls, or stored away in little cupboard-like partition spaces at the sides or back of the house. Above the fire belonging to each family is generally a frame of poles or slips of cedar, upon which clothes may be hung to dry, and dried fish or dried clams are stored in the smoke. Eating is a perpetually recurring occupation, and smoke appears to ooze out by every chink and cranny of the roofs of the large houses, the whole upper part of which is generally filled with it. The houses of the Kwakiool are not so large or so well constructed as those of the Haida, though, if Vancouver's representations of them are to be accepted as accurate, they are more commodious and better built now than in his time. The introduction of metal tools may have produced a change of that kind. Wood-carving is practiced, but not so extensively as among the Haida, and carved totem-posts are not nearly so numerous nor so large or artistic in design as among that people. Such examples of posts of this kind as occur are also invariably separate from the houses, and no instance of a carved post forming the door of a house was seen in any of the villages.

The most valuable possession of the Kwakiool and other northern tribes is the "copper" or copper plate of which the peculiar form is illustrated in my "Report on the Queen Charlotte Islands." A conventional face is often scraped out upon the surface of the "copper." The most valued coppers are very old and have been handed down for generations. These are known as *tlā-kwa.* Smaller "coppers" of modern manufacture are named *tlā-tloh-sum.* A copper, to be of value, should be of equal thickness throughout, except at the edges, where it should be thicker than elsewhere. When struck, it should emit a dull sound and not ring. The dentalium shell, named *a-tl-a,* was formerly used as a currency, but, as with other coast tribes, the blanket is now the unit of value. A somewhat inferior quality, known in the Hud-

son's Bay Company parlance as a "two-and-a-half point" blanket, is the standard, and is named *ul'-hul-as-kum.*

When a child has grown large enough to leave the little cradle, tied into which it spends most of its earlier days, usage demands that the cradle, together with all the wrappings and bark forming the bedding and its appendages, shall be carefully collected and carried to a recognized place of deposit. This custom is not now strictly adhered to with regard to the cradle, but is still obligatory in respect to the bedding, which is generally neatly packed in a box or basket, and laid away, never to be touched again. Every village probably has such a place of deposit. That for the Kā-loo-kwis village is a sheltered recess in limestone cliffs at the western extreme of Harbledown Island. It is named *kī-ats-a-kwāsh'*, or "cedar-bark deposit-place." Another similar recess in a cliff, filled with cradle wrappings, exists on the south side of Pearse Peninsula, east end of Broughton Island. At Mel'-oopa and at Hwat-ēs' there are similar places, that at the first-named village being beneath logs, at the back of the village, and not on the shore.

When a young man desires to obtain a girl for a wife, he must bargain with her parents, and pay to her father a considerable number of blankets. Owing to the great desire to accumulate blankets for the purposes of the *potlatch* or donation-feast, together with the scarcity of marriageable girls, the parents are very strict and exacting in this respect. The young man is often still further fleeced by his wife, who, at the instigation of her parents, may seize upon some real or imaginary cause of grievance and leave him. The father then exacts a further blanket payment for her return, and so on.

Medicine, or sorcery, as practiced by these people for the cure of disease, is much the same as among other tribes of the coast, though the peculiar tubular bone charm, employed by the Haida and Tshmisian, was not here observed. The sorcerer may be either a man or a woman, famed for skill in such matters, to whom their vocation may have been indicated by dreams or visions. Medicines may be given to the patient by his friends, but the sorcerer does not deal in drugs, devoting his attention solely to exorcising the evil principle causing the disease. This is done by singing incantation songs, the use of a rattle, and vigorous sucking of the part affected, which in many cases is kept up for hours and frequently repeated, and must always be handsomely paid for. Sickness is still, generally, and was formerly at all times, attributed to the witchcraft of enemies. Certain persons were known to possess the power, and were called *ē'-a-kē-nooh.* Such a malignant person, wishing to bewitch an enemy, is supposed to go through a series of complicated and absurd cere-

monies, of which the following is an outline: An endeavor is first made to procure a lock of hair, some saliva, a piece of the sleeve and of the neck of the dress, or of the rim of the hat or head-dress which has absorbed the perspiration of the person to be bewitched. These are placed with a small piece of the skin and flesh of a dead man, dried and roasted before the fire, and rubbed and pounded together. The mixture is then tied up in a piece of skin or cloth, which is covered over with spruce-gum. The little package is next placed in a human bone, which is broken for the purpose, and afterward carefully tied together and put within a human skull. This again is placed in a box, which is tied up and gummed over and then buried in the ground in such a way as to be barely covered. A fire is next built nearly, but not exactly, on the top of the box, so as to warm the whole. Then the evilly disposed man, beating his head against a tree, names and denounces his enemy. This is done at night or in the early morning, and in secret, and is frequently repeated till the enemy dies. The actor must not smile or laugh, and must talk as little as possible till the spell has worked. If a man has reason to suppose that he is being practiced on in this way, he or his friends must endeavor to find the deposit and carefully unearth it. Rough handling of the box may prove immediately fatal. It is then cautiously unwrapped and the contents are thrown into the sea. If the evilly disposed person was discovered, he was in former years immediately killed. If, after making up the little package of relics as above noted, it is put into a frog, the mouth of which is tied up before it is released, a peculiar sickness is produced which causes the abdomen of the person against whom the sorcery is directed to swell.

After death the body is immediately coffined, not a moment being lost. Should death occur at night, the coffin-box is set outside the house at once, till daylight may admit of its being disposed of. The face of the dead is first washed and the hair combed, and then the face and head are painted with vermilion and the body wrapped in blankets by near relatives or friends. It is then put into any box of a suitable size that can be found, generally one of those used for the storage of house effects or dried fish. The box so employed is named *tik-ī-ā'-tse*. The body is doubled up, and no hesitation is felt in using violence toward it in order to press it into the box. The graves of the Kwakiool are of two principal kinds: little scaffolds to which the coffin-box is lashed, high upon the branches of fir-trees, and known as *tuh-pē'-kh*; and tombs built of slabs of wood on the ground. Small tent-like erections of calico are now often substituted for the latter, and the bodies of relatives or friends, dying at different times, are in both cases often placed together. If a person of importance or much

respected, a canoe (previously rendered unserviceable) is often drawn up and deposited near the grave. The trees used for the deposit of the dead are often quite close to the village, but when a tomb is placed upon the ground, it is generally on some rocky islet or insular rock, which may be farther away, but is still in sight from the village. Such islands become regular cemeteries. Graves in trees are generally festooned with blankets or streamers of cloth, and similar appendages are affixed to poles in the vicinity of graves on the ground. Roughly carved human figures in wood are also often added. These sometimes hold in their hands wooden models of the copper plates which are so much valued by these northern tribes of the coast. Similar models are also at times nailed up on posts near the graves. At Pā′-as (Blunden Harbor) the upper part of one of these coppers (but one of inferior value) was found broken in two and affixed at a grave in token of grief. The lower part was not found, and had probably been used before on some similar occasion. At Fort Rupert and Alert Bay, bodies are now frequently buried in the ground, owing to the influence of the whites. Such a grave is named *tik-ī-ās.*

After the body has been deposited in the grave, a fire is made near it, in which some food is burned, such as dried salmon, fat, dried clams, etc., and all the smaller articles belonging to the deceased are thrown into the fire at the same time. The canoe, house, and other larger effects are then taken possession of by the son, father, daughter, wife, or brother of the dead, generally in the order named The wife or husband of the deceased goes into special mourning for a period of one month among the Queen Charlotte Sound tribes, or for four months among the Kōs′-kī-mo. The survivor lives during this period separately in a very small hut, which is built behind the house, eating and drinking alone, and using for that purpose dishes not employed by other members of the tribe. The near relatives of the dead cut their hair short, or, if women, cut a small portion of it off. A widow marks her face with scratches, in token of mourning; among the Kōs′-kī-mo she cuts her face with a shell, and does not generally marry again for at least a year. In some cases, about a month after death, the men of the tribe collect in a house to sing a song which relates the deeds and virtues of the deceased. This is named *sā′-luma* or *kwai′-um,* the "crying-song." Children are sometimes, in the same way, mourned for by the women. When at Mel′-oopa ("Nawitti") in 1878, the first sound we heard at daybreak was the crying and lamentation of the women, the song being taken up first by one and then by another, in different parts of the village. This, it was ascertained, was in consequence of the death of a boy which had occurred some time before.

In my notes on the Haida people of the Queen Charlotte Isl-

ands, the facts which could be obtained as to the *potlatch* or donation-feast of these Indians and of the Tshimsian were detailed. This custom is common to all the coast tribes of this part of North America, and has extended, though in a less marked form, into the interior of the continent. The main features of the custom are probably identical, or nearly so, among all the tribes of the British Columbia coast. They are certainly nearly the same with the Haida, Tshimsian, and Kwakiool peoples. Among the latter, this ceremony is known as *pus-a* or *ya-hooit,* these terms probably denoting special forms of the ceremony appropriate to certain occasions.

As a particular instance of the custom, let us suppose that a Nīm′-kish, of Alert Bay, has collected together as his own, or obtained control of, say, five hundred blankets, and wishes to make a potlatch to the Fort Rupert tribes. He goes to the Fort Rupert village and makes known his intention of distributing a thousand blankets at a certain date. He begins by lending out his stock of five hundred blankets, giving larger numbers to those who are well off, and particularly to such as are known to have the intention of giving a potlatch in return. This loan is reckoned a debt of honor, to be paid with interest at the proper time. It is usual to return two blankets for every one borrowed, and Indians with liberal ideas may return even more. The greater the number of blankets loaned out to any individual, the more he knows that his wealth and standing are appreciated by the stranger, who, later on, taking with him a thousand or more blankets, returns to his home at Alert Bay; at which place also, in due time, the Fort Rupert people arrive. The potlatch does not, however, then occur at once, as much preliminary talk, ceremony, and feasting are in order, and the Nīm′-kish must entertain their visitors—first one and then another volunteering feasts and diversions. It may also, very probably, happen that delay arises because the man about to give the potlatch has not obtained the requisite number of blankets, many being owing to him and others having been promised by friends whom he is obliged to dun. The Fort Rupert people, becoming weary of waiting, lend all the weight of their influence to coerce the debtors into payment, and these may, in the end, be forced to borrow from others to enable them to redeem their pledges—all such arrangements leading to interminable haggling and worry. At length, however, all is ready, and, with the accompaniment of much bombastic speech-making and excitement, the mass of blankets is distributed in exact proportion to the social position of those taking part—or, what is the same thing, in proportion to their individual contributions.

To surpass the man who has last given a potlatch, and acquire a superior standing to his, the next aspirant must endeavor to

give away more than a thousand blankets, and will strive as soon as possible to be in a position to do so.

The nominal excuses for giving a potlatch are numerous, the most common being, however, the wish to assume a new and more honorable name. The name proposed to be taken passes by common consent, if the potlatch shall have been successful and on a sufficient scale.

Should an Indian wish to humiliate another for any reason, he may destroy a great number of blankets or much other valued property. This, according to custom, leaves his adversary in debt to the amount of the property made away with. It then behooves the debtor to bring out and destroy a like or if possible a greater amount of property. If he is not able to do this, he lies under the reproach of having been worsted by his foe.

The difficulties attendant on any effort toward the improvement of the condition and mode of life of the coast tribes of British Columbia are very grave; and the actual results of missionary labors, such as those carried on by Mr. Hall among the Kwakiool, and other self-sacrificing persons elsewhere, are in most cases, to all appearance, small.

It is difficult to induce individuals to abandon their old customs and bad habits, and nearly impossible to prevent them from relapsing, from time to time, owing to the fact that they still live promiscuously among and herd together with the mass of the tribe. Since the arrival of the whites, the Kwakiool, equally with other tribes, have become, in a word, "demoralized." They have lost, to a great extent, their pride and interest in the things which formerly occupied them, losing at the same time their spirit and self-respect, and replacing it by nothing. It is comparatively easy at all times to obtain a sufficiency of food, and food is at some seasons—as during the salmon-run—to be had in the greatest abundance with very little effort. Beyond this, there is nothing more to occupy their time fully and to keep them out of mischief. They are restless and unhappy. In some seasons, good wages are to be obtained by picking hops in the vicinity of Puget Sound, and it has thus become customary for many of the tribes to go south in the autumn, nominally for this purpose, but in reality with no great prospect of obtaining work. They may then be seen leaving their villages in bodies in their large and well-built traveling-canoes, whole families together with their household effects and children, and three, four, or five paddlers to each canoe, setting out cheerfully enough on their voyage of two hundred miles or more. They may obtain a little money while away, which they invest in goods and whisky, if they can obtain it (and in this there is unfortunately very little difficulty). They live, however, in the vicinity of Victoria and other large towns in a

state of shameless debauchery, and thus very often return in a diseased state to their homes.

The condition of these people is in no sense bettered by endeavoring to teach them moral maxims or religious dogma. They do not appreciate the truth of the former, nor can they in their low mental state rightly understand the latter. To endeavor to do so is merely to imitate the procedure of the Indian shaman over the dying. If, on the contrary, you speak to them of means of improving their material condition, or deplore with them the rapid diminution of their tribe, the more thoughtful and mature listen with the greatest respect and attention. The problem is, fundamentally, an industrial one, and is to be attacked, if successfully, from that side. They are naturally industrious enough, and capable, though not so persistently laborious as the whites, and less easy to control than the Chinese. They obtain a certain amount of precarious employment in connection with the canneries and other nascent industries of the northern coast, but have not generally the offer of any permanent remunerative work.

It is thus primarily essential to establish industries among them which will remove the temptation now felt to drift to the larger settlements and towns. Improvement in mental and moral tone will then naturally follow.

LINES OF PROGRESS IN AGRICULTURE.

By Dr. MANLY MILES.

THE recent progress made in the study of social and political science, in which the principles of evolution have played an important part, must aid us in gaining a better knowledge of the laws of industrial development, and more consistent views of the real objects and available methods of industrial education.

The recognition of the fact that in the social and industrial progress of peoples, as well as in the relations of natural phenomena, there are laws of growth and development, of universal application, under which the modifying influences of surrounding conditions are brought in harmony in determining results, has widened our methods of study and research, and thrown a light on the history of the world's progress that enables us to trace the relations of cause and effect in many cases that had before been involved in obscurity.

In agriculture there is pressing need of the application of principles and methods that have aided in the development of other industries, to enable the farmer to devise the best possible system for the profitable practice of his art under the world-wide com-

petition which surrounds him, as the result of the wonderfully increased facilities for the transportation and exchange of commodities. He can no longer claim that the empirical knowledge of farming he may possess is the only consistent guide in practice, and he can not safely ignore the many lessons presented in the marked progress and revolutions that have been made in other industries, or the manifold benefits he may derive from the wide circle of sciences, which are now in their rapid development suggesting important applications in every interest and process of the farm.

Practice and science must go hand in hand, with the most hearty co-operation, if the problems in farm management arising from the world's progress and the consequent depression in prices are to be successfully solved. Every hint which the latest discoveries in science may present for his consideration must be closely studied, and its relations to practice carefully determined, or the best results can not be obtained. From the complexity and interdependence of all agricultural processes and their intimate relations to every department of science, it must be admitted that there is no business or profession in which so wide a range of knowledge can be profitably made use of as in farming.

The ruts followed by narrow specialists, and the ultra-conservatism of the so-called "practical men," are alike to be avoided, if real progress in the practice of agriculture is made. A broad and liberal culture, with special training and aptness for the work, is required in dealing with the practical applications of the latest contributions of science, as no department of research can be safely neglected in the broad field which embraces such widely different interests; and this fact must be fully recognized in the management of our agricultural colleges, or they will fail to accomplish the end for which they were established.

In the popular discussion of manual training in schools as a phase of the modern demand for industrial education, there is danger that too much stress will be laid upon the assumed advantages of manual dexterity as a preparation for acquiring some handicraft or trade, and that its real value as a factor in mental development and discipline will be overlooked in the efforts to give a practical bias to an elementary course of instruction.

A brief glance at some of the conditions under which the world's work is now performed will make it evident that breadth of culture and thorough training in methods of scientific investigation are of greater importance than manual dexterity in any special direction. The trades or handicrafts which formerly required an apprenticeship of several years for their mastery are now, in effect, made nearly obsolete by the invention of machinery, and specialization in the processes of production, together

with the demand for large investments of capital, in every department of manufacture, to meet the intense competition arising from the rapid development of new and improved methods, and increased facilities in the means of transportation and distribution. In manufactures of all kinds the margin of profits has been reduced to an extent that is fatal to small establishments, and production can only succeed when on a sufficient scale to make an aggregate of the small items of profit an object worth seeking.

The subdivision of labor required in the specialization of manufactures on a large scale, where machinery, adapted to the particular purpose, is made use of in every process, tends to diminish the demand for skilled artisans, unless they are needed as superintendents of labor; and even then executive ability, general intelligence, and a knowledge of business methods, are of greater importance than mere technical skill.

The work done by a skillful mechanic, under former methods, is now performed by an unskilled workman and a machine, under proper supervision, and with greater economy and certainty in the results. Dexterity is required in only a single movement or operation, which is soon learned, and, when a machine is properly adjusted to perform its special function, a boy with its aid becomes the equal of the most skilled artisan in the routine of work he has to do. With the exception of localities with scattered population and remote from the lines of trade and distribution, we shall find that wagons, carriages, agricultural implements of all kinds, boots and shoes, tinware, clocks and watches, and, in fact, almost every product of the industrial arts, can be purchased at a lower price than the artisan can afford to make them under the old methods of his trade, and his skill as a workman is only in demand to repair the articles originally produced under a specialized system of manufacture.

Moreover, in many of the industries competition is so sharp, and the margin of profit so small, on the leading object of production, that the utilization of what had been waste products has been found to be essential to financial success. In response to this demand for the working up and utilization of residues, the applications of chemistry have produced remarkable results, and in many instances what had been rejected as a waste has assumed a dominant position in the industry, and the original article of manufacture has in its turn become the by-product and of secondary importance on the score of profit.

Large investments of capital, specialization in production, the use of machinery in every process, and the consequent subdivision of labor in particular lines in which the technical skill of the handicraftsman is not required, together with the utilization of

waste products and the rapid exchange of commodities, mark the progress of activity in the industrial arts.

Industrial education in its widest sense, in which mental development and liberal culture are the leading aim, in connection with a thorough knowledge of the industries in their relations to science, should be promoted as an important factor in the world's progress, and the gaining of technical skill in the handicrafts which have been so largely superseded by modern improved methods should not be allowed to usurp a dominant influence.

In the struggle necessarily involved in the progress of civilization and social development, agriculture is fortunately exempt from many of the conditions of production which have a decided tendency to reduce profits in other industries, and aside from the effects of bad seasons, the ravages of insects, and similar agencies which are local in their influence, the competition arising from the rapid increase in facilities for transportation, which give remote localities a ready access to the markets of the world, becomes the most important element in determining the low price of farm products.

This competition can not be evaded, and its tendency must be to prevent any wide fluctuation in the market value of products; and the farmer can have no reasonable expectation of again obtaining the high prices for his products which have been realized in the past. As in other industries, the fact of a world-wide competition and a resulting small margin of profits must be accepted as a probable constant factor in the farming of the future. This should not, however, be considered as a discouraging outlook, but it should serve as an incentive to activity in developing improved methods that will give satisfactory results under the prescribed conditions of production.

To those who are familiar with the details of farm practice, and have also a knowledge of the manifold applications of science that are available in every department of production, the direction in which progress can be made in devising remedies for the present diminished margin of profits in farm products is obvious. Attention must be directed to the development of a complete and comprehensive system of farm management, in which the intimate relations and interdependence of interests, in every department of production, are fully recognized, and every detail of practice, under thorough business methods, is made to yield the best direct results, and at the same time contribute indirectly to the aggregate of profits by its favorable influence on other details of equal importance. This will, of course, involve the systematic and consistent application of every contribution of science to the art to secure the utilization of every element of production, and the strictest economy in the distribution of the required labor.

From the prominence given to the economics of farm management and the inseparable relations of practice and science, as factors in the progress of agriculture under its present well-defined conditions, the notion must not be entertained that a complete revolution in practical methods is needed. The general principles of farm practice have been well established by the teachings of experience, and the leading rules of the art are not likely to be superseded or essentially modified by any discoveries in science. The old landmarks which have been obscured or lost sight of from too exclusive attention to specialties of comparatively little importance, must be restored and clearly defined, as a foundation on which a superstructure of improved practice in harmony with the principles of science and the prescribed conditions of production may be safely developed. New methods are not so much needed as a systematic adjustment of details, under the old established rules, in order to secure greater certainty and exactness in results.

Development, and not revolution, must be the watchword of progress, and the generally accepted methods of practice should only be modified by a proper arrangement of details to adapt them to the new environment. Exclusive attention to special farm products, and intensive systems of cultivation, have been urged as a royal road to success, in what has been called "progressive agriculture," by those who have noticed some of the improved methods in other industries, and attempted to apply them in agriculture without any definite knowledge of existing methods of farm practice, or the available applications of science in the art. These mistaken views do harm from the defective data and hasty generalizations on which they are based, which tend to bring true science undeservedly into disrepute, and also by diverting attention from the real methods of improvement.

From wide differences in the conditions of production, it must be readily seen that the centralization and specialization in manufactures, and the consequent subdivision of labor, which have been found essential to success in other industries, can not be applied in agriculture. With the exception of the comparatively few cases in which peculiar local conditions may warrant a departure, to some extent, from correct principles of general practice, it will be found that the specialization of products, instead of mitigating the evils arising from active competition, will only add to their intensity.

The tendencies of high farming are in the same direction. Sir John Bennet Lawes has clearly shown, from experimental data, that intensive farming can only be successfully practiced when comparatively high prices for farm products are obtained; and he concludes that high farming can not be recommended as a remedy for prevailing low prices. In agriculture, increased pro-

duction beyond a certain limit, which will vary with different conditions, involves an increase in the cost of the product, and with low prices an increase in yield, under an intensive system of management, may be made to cost more than its market value. With prevailing low prices for staple products, mixed farming, when conducted on a comprehensive plan, that gives to each interest its legitimate influence on the aggregate of results, has many advantages which recommend it as the best general system of practice.

Of the available suggestions which the rapid progress and development of other industries may present for the farmer's consideration, strict economy in the management of labor, and the thorough utilization of waste products, are undoubtedly the most significant. These two topics are so closely connected in practice from their intimate relations to every department of production, that they can not be separately considered in planning a system of farm management.

The direct influence on the margin of profits, of the distribution and efficiency of the labor performed on the farm throughout the year, is, however, so obvious that it will answer our present purpose to refer to it as an element that can not be neglected in discussing other methods of improvement. The waste products of the farm, which are so generally neglected, require more than a passing notice; but the limits of this article will not permit a full discussion of the subject, and we can only call attention to their great economic value.

From a careful estimate, based on the best obtainable data for the year 1884, in which the most important elements of fertility are valued at their market price in the form of commercial fertilizers, the barn-yard manure (or what should be utilized as such under a good system of management), in the State of Michigan, is worth at least $35,000,000; and in the United States this residue, under the same method of valuation, gives the astonishing aggregate of $1,092,950,000, which is more than twice the market value of all agricultural exports for the same year.

Persons familiar with the details of farm practice in different parts of the country will consider it safe to assume that at least one half of this valuable residue is lost, through neglect and errors in management, from lack of knowledge of the best methods of conserving the elements of fertility. The annual loss to farmers of the United States of a sum equal to, or exceeding, the market value of all agricultural exports, which they may readily prevent by a thorough and consistent system of management, is a matter of the first importance in considering the available means of agricultural improvement.

It does not aid the farmer in the ordinary routine of his work,

or place him in a better position to overcome the evils of the intense competition to which he is subjected, to urge upon him the dangers of soil-exhaustion from the loss of the elements of fertility in the products sold from the farm. Profitable farming can only be practiced when the surplus products of the farm can be disposed of at remunerative rates in the markets of the world; and these products must of course contain chemical constituents that might, under proper conditions, be looked upon as elements of fertility. But of what use are elements of fertility if they can not be converted into products that can be sold and made to contribute to the legitimate income that is the object of the farmer's labors? It is a false assumption in economic science that the sale of a product is to be deprecated as a positive loss to the means of production; but farmers are not alarmed by such sensational claims, as the fallacies of the proposition are readily detected.

American farmers will continue to sell grain and animal products of various forms as long as there is a demand for them outside of their farms, and this is of course the only available resource of profitable production; but they need not fear the evils of soil-exhaustion from this source, notwithstanding the warnings of alarmists who overlook the complex compensating agencies of Nature, and fail to recognize the real sources of diminished production. The history of agriculture and our knowledge of science agree in teaching that the causes of diminished productiveness that are often noticed and referred to as indications of soil-exhaustion, can not be exclusively attributed to the loss of constituents removed from the soil in the crops sold from the farm, but rather to the failure to conserve the available elements of fertility, and keep them in active circulation, by a judicious system of cropping and soil management.

If the fertilizing constituents of the barn-yard manure which are now wasted were utilized by being converted into farm products of marketable value, the gross agricultural exports of the United States might be more than doubled without making our soils appreciably poorer in any of their essential constituents.

It must be admitted, if the figures already given are approximately correct—and there is good reason to believe that they understate rather than exaggerate the real facts of the case—that the disposition made of the residues of the farm is of far greater importance in the farming of the future than the aggregate of soil constituents contained in the products exported.

Under the present conditions of production the problem for the farmer to solve is, How can the sale of farm products be increased without diminishing the productive resources of the farm? For many obvious reasons the purchase of commercial fertilizers can not be admitted as the constant factor required in

the solution of this problem. The profitable use of purchased manures must be limited to particular localities and special conditions of production, and they can not be made available to any extent as the staple source of fertility in general farm practice, as the markets of the world could supply the wants of but a very small proportion of the farms of the country.

Improved breeds of animals, and improved plants and seeds, in great variety, especially adapted to particular purposes, can now be obtained on every farm, and the rapid development of the mechanic arts has provided the most perfect implements and machines for economizing labor in every process. These lines of progress furnish important contributions to the means of profitable production, which the farmers of the country can not fail to appreciate. There remains, however, an extended field that is practically unworked, in which original investigations are needed to place our system of agriculture in full harmony with the requirements of the age.

From a practical standpoint, and as offering the most probable means of substantial progress, under present conditions of production, the subject of paramount importance to the farmer, and which should, therefore, receive a prominent place in a course of instruction in practical agriculture, is the utilization of farm residues of all kinds, with their available stores of the elements of fertility. Among these, barn-yard manure, from its obvious direct relations to the economics of production, should receive the share of attention its importance demands; but it must not, by any means, be looked upon as the only residue of the farm of economic interest. In a consistent system of practice, these residues must be made an efficient part of the circulating capital of the farm, and converted as rapidly as practicable, and with the least possible waste, into products of marketable value.

From the complex phenomena presented in the nutrition of plants and soil metabolism, the best methods for utilizing these residues can not be formulated in specific rules of practice that are of universal application. On every farm special conditions will be found which require intelligence and judgment in the application of general principles; and opportunities will be afforded, in each particular case, for the adjustment and balancing of the many contributions of science to meet the practical demands that arise from the varying combination of details presented in a wide range of topics, including the amelioration of soils by drainage and thorough tillage, the judicious arrangement of a succession of crops that will provide for a suitable supply of food for the animals of the farm, and the profitable appropriation of every element of fertility as soon as it is made available for the purposes of plant-growth; together with the economic conversion of

the vegetable products into marketable animal products, and the efficient distribution of the required labor throughout the year in accordance with strict business principles.

In order to realize the full benefits of efforts to improve the practice of agriculture in this direction, the increase and diffusion of knowledge relating to the applications of science in practice must be promoted and encouraged as an essential element of success. There has never been a time when the advantages of agricultural education were so clearly apparent, or the conditions of practice so favorable for the general recognition of the practical value of a knowledge of science.

Under this encouraging aspect of the times, the agricultural colleges of the country can now be made to command a dominant influence in developing an improved system of agriculture, by conducting their practical departments on a higher plane, that will fully supplement and emphasize the economic value of the class-room instruction in science, so that farmers may look to them with a reasonable expectation of obtaining the information needed in planning the best systems of practice.

A course of instruction in practical agriculture can not be consistently confined to the limited range of the established routine of farm-work, but it must be supplemented and widened by a full discussion of the applications of science in every process of the art, and the practicable means of making them available sources of profit. The labor system must likewise be made to contribute its share to the leading purpose, it should have in common with other departments, of developing in the student correct habits of observation and investigation, and he should be made to trace, in every detail of farm-work, illustrations of the principles taught in the class-room, so that he may acquire a proper appreciation of the intimate and legitimate relations of practice and science.

The sciences relating to agriculture have already made sufficient progress to place the leading principles of farm economy on a consistent basis, and they serve as a safe guide in tracing the lines of future progress, or the direction, at least, in which improvements in agriculture may be made; but there are, as yet, many unexplained details that need further experimental investigation. The invaluable experiments made at Rothamsted during the past forty years have fortunately laid the foundation of a consistent system for utilizing the residues of the farm; but it must be admitted that, aside from these admirable researches, there are few, if any, experiments on record that are of practical interest in this direction. The importance of additional experiments on the lines of investigation so successfully followed at Rothamsted can hardly be overestimated.

The annual preventable loss to the farmers of the United States of over $500,000,000 must serve to emphasize the advantages that may be derived from the thorough and systematic study of the economics of agriculture, and the pressing need of the increase and wider diffusion of knowledge in the domain of applied science. With clear and well-defined notions of the scope and essential factors of the required work, including an extended and accurate knowledge of science in its several departments, and an intimate acquaintance with the details of farm practice, a well-planned system of experiments, conducted with reasonable persistence and skill, can not fail to give results of great practical value to every farmer.

FALLACIES IN THE TRADES-UNIONS ARGUMENT.

By J. B. MANN.

THE errors which prevail in relation to certain foundation principles of the labor movement seem to justify an attempt to illustrate the subject, in a more commonplace way than is customary, by citations of such familiar incidents as meet the ordinary experience and thought of men in the common walks of life. The labor question is like any other, in respect to its dependence upon laws which can not be repealed by man or overthrown by organizations of classes or individuals. Everything in the world is subject to laws of its kind, from which there is no escape, whatever we may wish or attempt. Labor is no exception, and we must, therefore, ascertain what the laws pertaining to labor are, and then conduct the discussion in the light of them.

At the beginning, the most obvious thing concerning labor is, that it is a commodity. It is a thing bought and sold, and is of little value except under that condition. There is no such thing as society where labor is not bought, sold, or exchanged, and we can not conceive of a civilization which does not make labor a commodity and treat it as such.

The reason why another condition of things does not exist is, that natural law comes in and will not permit it. Man has need of very many things but he has time to acquire the skill to make only a few of them. He can learn and become expert in only one or two trades, and unless he is expert his trade will be of little use. The carpenter who builds but one house in his lifetime can not be much of an expert, especially if he has to raise his corn and potatoes, make his clothes, his tools, his household utensils, and whatever else is required while he is building the house. It would take a single man so long to learn the trades necessary to supply him-

self with comforts, that he would and could have no amount of comforts without a division of labor, under which each man should give his attention mainly to one thing, and that thing the one best suited to his faculty. Necessity, therefore, compels an exchange of labor, and thus labor becomes a commodity, and a thing of barter, transfer, and price.

The next important item in regard to the matter is that, to effect the exchange of labor, capital becomes a necessity also. A man chooses to be a farmer. He can do nothing at farming without a plow, a hoe, a shovel, and other tools, and these are capital. If he did not have the capital to buy them, he would have to make them, and have to learn how to make them, and have to dig the iron-ore, learn to smelt and prepare it, and work it, and learn to make the anvils and hammers, and nails, and screws, and all else used in the construction of a plow. But capital standing at the door with a plow ready made, the farmer can commence business the very day he gets title to his land.

These observations are elementary, it is true, but they are necessary as an introduction. They establish two points: First, that labor must be exchanged to be of any avail; and, second, it must be assisted by capital. It will be seen that the laborer must work along the line of diversity and development. Men instinctively do this generally in the beginnings of a community. One man becomes a blacksmith, one a carpenter, one a mason, one a shoemaker, and so on, in submission to the laws governing labor —the laws of diversity and development. They know, without argument, that two shoemakers and no blacksmith would be a foolish and unprofitable arrangement, and hence employments are divided spontaneously. As society advances, the occupations multiply; that is, they divide more and more, and by doing so each person has a chance to select the one which best suits his taste and capacity. And in this way the highest power of the community is developed. The best blacksmith takes the place of the bungler, the good workman in all branches finds employment, and the inexpert retires to some other calling, or perfects himself so as not to be driven to the wall. Society demands the best, and, as it advances, secures it more and more. The best tailor, and the best lecturer, and the best lawyer, are never idle; and they are produced by the law of diversity and development.

It is equally certain that capital is produced by labor, and is the natural result of labor husbanded and taken care of. The existence of capital is due to the previous existence of labor, but its existence in large quantity is due to the joint effort of labor and capital. The existence of the plow, which is capital, has kept the farmer from starving, and, as all other people depend upon the farmer for food, the plow has kept us all from starving. In the

same way the spindle and the loom have kept us from freezing; and they are capital.

To sum up this part of the case, we say that in order to have development we must have capital, that the amount of capital must depend upon the extent of development, and the amount of comfort attainable upon the union of capital and labor, working along the line of development. The man who can make two shoes in a day will supply double the needs of the shoe-wearing community that the man will who can make but one shoe in the same time, and, the world over, he will be pronounced the better man. Obviously, two things will certainly follow the introduction of such a workman: the community will get its shoes with one half the number of days' labor from the expert workman that were required when they were made by the inexpert workman, and it will have a citizen who will be accumulating capital, in lieu of one who could only barely make a living; for it will cost twice as much to clothe and feed the shoemaking force of a community when it takes twice the number of men to do the work, and, with double the expense, only half the capital can be accumulated.

Many years ago a distinguished philosopher and writer said that the man who could tell how to make two blades of grass grow where but one grew before, would be a great public benefactor. With two blades of grass on the average in lieu of one, we should have double the pork, beef, mutton, hides, wool, milk, butter, and cheese, and we could raise twice the corn, wheat, and potatoes; or, if these were not needed in such quantity, we would have to spend only half the time in meeting our wants. We all understand how it works. We know that a farmer who raises, year after year, but one ton of grass to the acre, is not only a poor farmer, but must be a poor man also, compared with the farmer who contrives to get two tons to the acre. We have all seen both kinds of farmers, and are all agreed as to their relative merits. The man who can accomplish most in the least time is unanimously regarded as the best man in every occupation of life in which he engages.

Universal opinion, therefore, establishes a goal for ambition, and men strive to reach it. We recognize success to be the goal, and success depends on the ability to do the most in the least time. We must work toward success; for working against success is sure to end in disaster. No man plants corn, and then, when the crop has been gathered, sets his granary on fire and burns it up. No man goes to his field and stands all day with folded arms, expecting that the crop will grow without planting and hoeing.

We have, then, a test by which to try all the plans which are projected to advance the interests of mankind, and it is so simple that any man of common understanding can apply it. Let us

apply it to some of the projects of the labor-reformers, using all candor and honesty. As I understand it, the trades-unions are conducted, so far as the members find it possible to conduct them, upon a theory exactly opposite to the universally recognized law of success. They make a regulation that no master-workman shall have more than a given number of apprentices. They say that no man shall work before a certain hour in the morning and after a certain hour in the evening. They provide that no man shall work for another who has treated a particular workman in a way not approved by the union. They require that, when one can not get a given price for labor, he shall cease work and remain idle. In some cases they contend that a good and specially effective hand shall have no better wages than an inferior and less effective one; and practically they strive to place a limit to the power of the community to provide for its support and comfort. The right to do all this I do not intend to discuss, but only its wisdom. Is it in the line of the conditions of success as we know them?

What makes a prosperous farmer? The answer is, industry, knowledge, adaptation of means to ends in such a way that the greatest crops shall be raised from the fewest acres. What makes a prosperous town or village? Evidently the development and judicious application of its forces to production in all departments. If we see a township with a hundred farms, and each farmer managing so that he secures only eight tons of hay from twelve acres, we shall find scraggy and lean cattle, small, inconvenient buildings, poor fences, and all the signs of unthrift, dilapidation, poverty, and decay. There is no doubt about it. Compare such a town with an adjoining one where by intelligence and active industry the farmers get twenty-five tons of hay from twelve acres. In the latter town will be found double the number of cattle, and more than double the number of the conveniences and comforts of life. The difference between two such towns is in what is termed accomplishment. That is to say, one town has shown what the result is from limiting its productions to less than one ton of grass per acre, and the other has shown how the face of things appears where all hands have tried to get two tons of grass per acre.

Now the same general result would follow were the main pursuit of the population mechanical instead of agricultural. Start the shoe business in two towns side by side, making the hours of labor six in one and twelve in the other, and in twenty-five years the latter town will be able to buy the former out four or five times. This, because the capital saved in the several years will have been earning all the time, while the other town will have used up all its earnings from year to year, and will stand at

the end of twenty-five years at the same point whence it started. In other words, limitation and curtailment of resources inevitably tend to poverty, and development and use of resources surely tend to prosperity and comfort. The limitations of the unions, all of them, are on the line of non-accomplishment, and are avowedly designed to hinder or check production. They are adopted on the theory that with less production wages will rise, and in the rise of wages the laborer will receive as much compensation for one day's labor as he otherwise would for two days' labor.

Under certain contingencies, and for a time as to some individuals, that may happen. In a temporary glut of the market, curtailment of production is found to be a remedy, or a partial one, for unduly low prices, but even then the laborer has to lose all of the time needed to free the market from the excess of goods. Labor as a whole gains nothing, but loses. The farmers who raise only half a crop to the acre do not find in the long run that they get as much money as their neighbors who raise a full crop, notwithstanding there are short periods when hay which ordinarily fetches twelve dollars per ton will bring twenty-five dollars. Nobody has ever seen a half-crop farmer permanently prosperous out of the resources of his farm, and nobody has seen general prosperity when half the laboring population was idle, or when the whole laboring population was idle half the time. It is impossible in the nature of things, because the rewards of labor all come from the productions of labor, and when less is produced there must necessarily be less to divide. The price of a ton of hay in the market may go up from ten dollars to twenty, but the laws of production and labor are not cheated, nevertheless; for the way has not yet been discovered by which the one ton will sustain the life of the ox and the horse as long as the two tons will; and in spite of the double price the reduction in quantity is a dead loss to somebody, and in the end comes out of the consumers of meat, who are all taxed in higher prices they have to pay.

The direct effect of less labor is fewer articles for use, comfort, and luxury. This is the avowed purpose of the unions in trying to compel all laborers to agree to a limit for the hours of labor. They propose to sustain prices by creating comparative scarcity of goods, and claim that thereby they can secure as many comforts as before with shorter hours of work. But how? If they work enough faster, so as to make as many goods in six hours as they before made in ten, they would save in hours, it is true, and get as many goods. But this is not the aim. No scarcity would be attained in that way, and consequently prices would not be raised; and the conditions of poverty and prosperity would remain precisely as they were. It would be simply a question whether it is better on the whole to work leisurely or in a hurry, and unions

are never formed on such a question as that, for the plain reason that it suits some temperaments to hurry and other temperaments not to hurry, and a change can not be effected by regulation. The main object is more compensation for the same or less service, and it is expected to come by causing a scarcity of products; that is, with less to divide, the share of each will be greater—a contradiction in terms, regarding the matter as a permanent condition.

Let us illustrate in another way. We ask, Has man been provided with a surplus of force, the exercise of which, in efforts to get a good living, operates to prevent him from getting a good living? If this be the case, a reduction of force must prove beneficial. Are laboring-men prepared to admit this? Would it promote wealth to have every able-bodied man lose one foot, so as to reduce the aggregate activity of the community one half? Would a community of one-armed men get a more comfortable living than a community of two-armed men? Do we find slow, sluggish, time-wasting, inactive, and unindustrious peoples getting ahead and living a more desirable life than the vigorous, pushing, and constantly employed peoples? Yet a reduction of force a fourth, a third, and even a half, it is asserted by some, will enable the users of force greatly to improve their circumstances.

If we produce less we shall have more, according to the theory which demands less production as a means of getting richer. According to this theory, the little busy bee which improves each shining hour, and gathers honey *all* the day, makes a grand mistake. It should adopt the eight-hour system—gather less honey, and have more leisure.

The question of hours of labor as affecting the health and the length of life and happiness of laborers is not under discussion here, but simply their bearings upon the financial status of the men who do the work of the world. The workers are aiming at an improvement of their finances and at the abolition of poverty, and it is important to know whether the means proposed are adequate to the end, and even whether they tend to improvement of pecuniary conditions. Under some circumstances and for short periods, in given cases, a shortening of hours of labor may not cause a decrease in compensation. For instance, a man with plenty of money, having made up his mind to build a fine house, may go on and build it, though he pay ten-hour wages for eight hours' work. A number of men may do the same thing, and the mechanics who are fortunate enough to be in their employ will not be losers in consequence. But these cases are the exception and not the rule. When it comes to the great body of men who would build, the higher cost operates as a prohibition to building, as thousands of men would be unable to build and pay thirty per

cent more for labor and for materials; consequently they would continue to live in their old houses, thus reducing the quantity of work to be obtained, thereby throwing hosts of workmen out of employment, and causing a surplus of labor to be offered in the market, to the depression of the wages of those mechanics who have a chance to work. Further than this, in the end, a scarcity of houses would ensue, causing an advance in rents, to the detriment of all workmen who do not own the dwellings they live in and must pay the advance in rents. The processes would be somewhat slow, and be combined with so many obscure influences, that men would hardly know of any change, but after a few years they would realize that somehow the number of people struggling for a bare living had in no wise diminished, and the hardness of their lot had been in no way ameliorated.

That laboring-men are gradually coming to see the truth in these things is seen in their changed views in relation to strikes. A few years ago prodigious efforts were made to get men to strike. It was a favorite remedy with the leaders, and large promises of grand results were made and believed in. The strike was formerly the favorite panacea for keeping up prices of labor, but to-day the long-headed and wise men in the labor movement advise a resort to it only in cases of great aggravation, and not then until after all other known remedies have proved ineffectual. This change in sentiment could not have happened if former strikes had met expectations. It is asserted by labor-men that there is more distress among them than at any former time, and the good old days of thirty and forty years ago, when strikes were almost unknown, are pointed at as the true contrast of the present. If strikes had measurably succeeded, there would have been no ground for the assertion, for success could be proved only by showing an improvement in the circumstances of the classes for whose benefit they were instituted. If compensation after a strike is no better than it was before, it can not be said that the strike succeeded in securing better compensation; and, on the other hand, if compensation has been improved, the assertion that harder times prevail now than formerly must be untrue, and there is no reason why laboring-men should not keep on striking.

But it is said, in reply to this, that strikes are not favored now because the poverty of the working-classes is so extreme that a portion will yield before the proper result can be attained. This is the undoubted fact, and it is one which settles the case against inaugurating strikes. Men can not succeed in anything where their means are inadequate; and so long as laborers are poor, they can no more cease work long enough to make goods scarce than they can build ships and go into the carrying-trade. The circumstance of poverty is fatal to the luxury of frequent strikes, and

the time lost in carrying them out so cripples the workmen that they fail of being a remedy for low prices of labor.

If we take two families in rather poor circumstances, and apply the principle of short hours of labor to one and not to the other, we can get a tolerably clear idea of its operation. The families consist, say, of the fathers and mothers and six young children each, all the children being too young to be of great assistance. Mrs. A rises at five in the morning, prepares breakfast, after breakfast clears off the table, washes the dishes, gets dinner and tea, clears up, at some time sweeps the rooms, sews a little, knits a little, mends and darns a little, and thus uses up nearly every moment of time until ten or eleven o'clock at night. Her house is kept in order and her children appear at school and church neatly clad, hold up their heads with a self-respecting air, and are able to associate with pupils quite superior to them in pecuniary circumstances; but it is due to sixteen hours of diligence and well-applied labor on the part of the mother. On the other hand, Mrs. B holds to the theory that eight hours of labor is enough, and puts it in practice. She omits the sweeping, and her house and furniture become untidy and unattractive. She omits the darning and mending, so that her children can not go to church, and go to school in rags, whereby they fall in standing and association, acquire the manners and morals of the neglected classes, and grow up cursing destiny and preparing to retaliate on society for having consigned them to a life of ignorance, want, and degradation. The contrast between the two families in the matters of comfort, morals, prospects, and happiness is striking. But contrasts of the kind are often seen; and it is generally recognized that the difference is owing to the unremitting fidelity and industry of the Mrs. A's as set off against the lax work of the Mrs. B's. Should Mrs. A shorten her hours of labor to eight, permanently, the family, instead of faring better, must inevitably fare worse; and what is true of one family is true of two, of twenty, of a hundred, and of all the community dependent on labor for support. This will remain true until the time comes when eight hours' labor will pay for the comforts now secured by twelve or fourteen hours' labor.

WHETHER superficial knowledge be beneficial or deleterious may depend on what is meant by the term. If we mean by it incorrect knowledge, that certainly is worse than no knowledge at all; if simply a small amount of knowledge, the least is of advantage. A little knowledge on a great many subjects, as Mr. Balfour has said in his rectorial address at St. Andrew's, will conduce more to happiness and enjoyment, and will better render a man's mind wide and liberal in tone, and free from the prejudices of ignorance, than a great deal of knowledge on one subject alone. The best condition is to know as much as possible on one subject, and cultivate a little knowledge on many others.

BOTANY AS IT MAY BE TAUGHT.

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AT the outset, let the reader's mind be free from any idea that the writer thinks he has found a new or royal road to botanical teaching, or that the method here to be stated is any panacea for the ills which follow as a natural result from the old stereotyped ideas of education. He presents it because it has borne good fruit, and combines some features which he has not known of having been dovetailed together elsewhere. This last reason may only give a wide exposure to his ignorance of the ways of botanical teachers. And yet the fault, if it is a fault, lies in part at the feet of his collaborators in natural history. The thought has often occurred to me that botanists do not say enough about their class-work. There is, of course, a strong incentive to let the labor with students be of secondary importance, and to bend all the energies toward some special end in systematic anatomical or physiological work, and thereby to feel that the space in the journals is only open to things new to science. A person, however, with large classes to carry, which consume the greater part of his time, often wishes that the periodicals contained more hints and suggestions as to the most approved methods of imparting knowledge in a branch of natural history which all advanced teachers agree is passing through the diseases and other dangers and trials incident to childhood. At the present time there are nearly as many ways of carrying a class through a course in botany as there are active teachers in the field. Some experienced teachers begin the study with the unicellular plants, and pass upward to the more complex structures. Others advocate opening the study with the kinds most easily found by the untrained eyes and best illustrating all the parts of a highly organized plant. Still others are quite indifferent to method, and consider the subject nearest at hand as the best to use. There are teachers who cling closely to some text-book, and measure their success by the same yard-stick used by the mathematician. Others go to the opposite extreme, discard all texts, and study only the things themselves. The great end in view in this last method is the teaching of the student to see for himself and to finally become an earnest, thoughtful, conscientious, and independent reader of the great open book of Nature. The writer confesses a strong feeling of preference toward this last view of instruction in botany. He would have his students see and think for themselves, and yet realize that others have gone over the same path and passed far beyond them in every branch of the road they are traveling.

No one but the teacher knows how hard it is to dispossess the minds of some students of the old inherited ideas of learning from books. They take as naturally to memorizing a page of text as young ducks to water. In fact, they come to us with no other ideas of education. Like many other mammalia, they are born blind—to the world of natural objects—and, worse than all, they learn to read before they acquire the power of sight. But, thanks to the Kindergarten system, object-teaching is coming slowly forward, and before many generations pass we may hope to have a natural method of education, because then the youth will have grown up under its vitalizing influence. Until then it may be that each teacher will strive to fit his abilities and notions to those of his pupils, and methods will vary and opinions widely differ. It seems all the more important that the ways and means of instruction should have a place in the journals which deal particularly with the subjects taught.

During the past two years the writer has attempted to lead large classes in the direction which it was hoped would develop individual research. The results have been sufficiently satisfactory to warrant a mention of the plan—not for its newness, but that it may draw out criticisms to be used in improving the method, and to suggest a similar trial by those who are similarly situated. The point, in short, of this paper is to show how a sophomore class of thirty-seven members, in an agricultural college, was, the past year, carried through a term of botany lasting seventeen weeks, and reaching from July 20th until near the middle of November. Three class-room exercises of an hour were held each week, and one afternoon weekly was spent in the botanical laboratory. The class had already taken one full year of botany, with recitation exercises occurring twice per week, and among other work each pupil had made a herbarium of fifty species, collected, pressed, mounted, and labeled by himself. The class was fully up to the average for colleges of this sort, in both years and ability, and contained fourteen ladies and twenty-three gentlemen. No text-book was used, and all formal lectures were dispensed with. The work assigned for the term was placed under five heads, namely: 1, herbarium; 2, economic subjects; 3, orders; 4, topics of research; 5, laboratory work. In the first place, fifty species, neatly mounted on standard herbarium paper, were added to the herbarium of the previous term. Each student in the lecture-room was assigned a chair with a broad table-arm for holding specimens, hand-lens, etc. During the first six weeks the class exercises were devoted to plant analyses. The specimens were collected in abundance by the students, in turn, and from three to five species were classified during the hour. Dried specimens of the several genera under consideration were brought

from the college herbarium, and, when a student had completed his determination, he was expected to make comparisons with the authentic herbarium specimens. At the end of the first half of the term each student submitted his collection, in portfolio, and about ten days after it was again brought for the examination. This was entirely oral, with the specimens before the student. Questions were rapidly asked upon a wide range of subjects and varying for different students. Ordinal characteristics, botanical names, habitats, striking peculiarities, comparison of species of same genus, contrasts of genera of different orders, are some of the groups into which the questions fell. About five pupils could be thus quizzed per hour.

If there should be any lack of specimens, owing to stormy weather, or spare moments from any cause, the economic subjects were resorted to for filling the hour. These subjects form the second feature of the work of the term, and were selected in order of importance, and assigned four to each student, who prepared for recitation upon them. Each set of four subjects was made to embrace as wide a range of vegetable products as possible. The following are two fair samples: Camphor, ebony, orange, and tomato; Brazil-nut, flax, opium, and turnip. These topics were looked up in the college library, using several books the titles of which had previously been placed upon the lecture-room blackboard as "books of reference." The value to students of learning how to use encyclopædias and other reference-books in work of this kind is almost as great as that of the actual information gained upon the subjects in hand. The students took full notes of the recitations upon the topics, and the questions for examination, following this work, were such as to require the grouping and classifying of subjects. A list of general questions was placed upon the blackboard many days before the examination, and from this set a number were finally selected as tests. As samples the following may be given: Treat of the leading commercial gums; the tropical fruits; plants grown for their roots; commercial spices; the leading drugs; Iowa's most important food-plants, etc.

Besides these economic subjects each student at the beginning of the term selected a natural order upon which to prepare, for the class, a paper of ten to fifteen minutes in length. The economic topics easily prepared the way for this more thorough work upon some particular group of plants. For example, the student who selected the pulse family (*Leguminosæ*) had the advantage of all the notes upon the various gums, drugs, dyestuffs, precious woods, food and fodder plants of the order. In like manner, the writer upon the grasses and grains (order *Gramineæ*) or the palm family (*Palmaceæ*), could use the information previously pre-

sented upon any economic subject in his respective group. Limited space prevents the reproduction here of even a part of a single paper, thus prepared, although the desire is strong to do it. Some students exhibited much originality in grouping the most important facts and followed up the work until all the sources of information were exhausted. The views of different authors concerning the relative position and "naturalness" of the orders frequently came up, and many important points in systematic botany appeared for consideration.

Some teachers may think too much time was given to this library-work. Let it be kept in mind that at this same time the field-work upon the collection was being prosecuted. During the afternoon a student may have searched in the field and forest for living spicemens, and the following evening hunted in the botanical alcove of the library for the facts concerning an economic topic, or collected notes for a paper upon a natural order. The work outside of the class-room and laboratory was a wholesome and healthful mixture of searching in the open air and among the library-books. The habit of looking up subjects in a list of authorities is exceedingly valuable, and one which many students, of themselves, never acquire. When at the same time they get information upon the most practical of subjects, a double purpose is served. A breadth of view of economic botany is thus obtained which does not come from conning a text-book or listening to a course of lectures.

Each student took full notes upon the orders as the papers were presented in class. At the close an examination was held, which consisted in writing upon six out of ten orders chosen by lot from the whole list. Each student, of course, omitted his own order if it chanced to be among those drawn.

In direct contrast with the work in the library was that upon the topics of research. These subjects were also given out at the beginning of the term, so that observations and experiments could be extended over fully three months of the growing season. This is the fourth branch of the term's work, and was designed to lead the students to become investigators in a small way, and learn to ask questions of and receive answers directly from Nature. How well this work was done can only be determined by a careful reading of the papers prepared under this head. It is impossible to more than indicate the results obtained. In the following notes the topics of research are given within quotation-marks: The student with "The Wild Plants of our (the college) Public Grounds" found one hundred and eight species in thirty-four orders. The paper gave the number in each order; those which were herbs, shrubs, or trees, etc. For example, there were twenty-seven compositæ, ten polygonaceæ, five cruciferæ, ten families with two

species each, and thirteen orders with each a single representative. Sixteen were not indigenous. Observations in all intensities of light and darkness led to a paper upon the "Sleep of Plants." The honey-locust proved a good subject for observation upon these nyctitropic or sleep movements. Two papers were upon the germination of seeds. In one those of pumpkins and beans were selected, and in the other corn and peas. These seeds were planted by the students in deep dishes and placed in their windows. A careful record of daily observations and measurements was kept, the idea being for the students to learn how to conduct careful experiments. A large area on the blackboard, covered with neat drawings of young plants in all stages of germination, illustrated this work to the other members of the class. The student with "Plants having Two Kinds of Flowers" first worked independent of any guide, and finally closed his studies with a review of Darwin's book upon this subject, a summary of which was presented to the class. Sufficient study had been given to the subject to greatly increase the interest in the book, and the student volunteered the remark that it was exceedingly valuable reading. The "Flora of the Dry Beds of Streams" was exceptional, because the season had been one of extreme drought. Fifty species were found, and three fourths were plants common to low ground. Many species of the remaining one fourth were found elsewhere on gravelly banks. A few were water-plants which continued to survive. Twenty-two orders and thirty-eight genera were represented. Two topics in difficult systematic work were assigned, namely, to one student "The Solidagos," and to another "The Asters." A key was formed for the rapid determination of the local representatives of these two genera. Good herbarium specimens were prepared of the various species and submitted to the class. We have thirteen species of solidagos, and, of the one hundred and fifty asters in the United States, Iowa has twenty-four, fourteen of which are found in the vicinity of the college.

Several of the topics required microscopic work, and the students with these spent extra time in the laboratory. A microscopic study of "Terminal Buds" revealed the whole plan of a year's growth in such buds as those of the horse-chestnut, where flowers in miniature were so numerous that forty could be counted in a single longitudinal section. "Plant-Hairs" was a subject worked almost entirely in the laboratory. A division was first made into those consisting of a single cell and those with more than one. For convenience of further study the subject was again divided into the hairs of flowers, of leaves, of stems, and of roots. The "Seeds of Cruciferous Plants" furnished the pupil subjects for a study into the minute points of classification in the ordinal key of this very natural order, especially as regards accumbent, incumbent,

and conduplicate embryos. The student in charge of "Abnormal Forms in Plants" was able to report a number of monstrosities. All members of the class were expected to contribute, if possible, to this paper upon teratology. A toad-flax (*Linaria vulgaris*) flower with five spurs instead of one was found; two blossoms of an onosmodium were united into one; a spike of foxtail (*Setaria viridis*) was divided into seven prongs, and perhaps the most interesting was the finding of many pistils of prairie pink (*Phlox pilosa*) in which there were four cavities instead of three, the normal number. The ovaries for the whole order *Polemoniaceæ*, to which the phlox belongs, are tricarpellary, and therefore this is a variation which affects the ordinal description. Under the "Dehiscence of Fruits" the pods and capsules of various plants were studied, including those of impatiens, milkweed, violet, and poppy. Observations were made upon the "sensitive stigmas" of the trumpet creeper (*Tecoma radicans*), which were found to close in one minute when most active—that is, with freshly opened flowers on a bright, hot day. The "Insects Injurious to Plants" furnished abundance of material for an extended paper, and the investigation of the "Root-System of Corn" enabled a student agriculturally inclined to become familiar, by spade and shovel, with the manner in which the roots of our leading crop are spread in the soil. A contrast between "Grape and Cucumber Tendrils" and a study of "How the Virginia Creeper Creeps" were two subjects which, when specially investigated, enabled the students to become familiar with a number of questions which are not easily answered by a study of books. The "Stipules of Various Plants," when contrasted by making drawings of the living specimens, made a paper of interest to all. The clovers and docks were investigated in particular. The leaf-type of the great rag-weed (*Ambrosia trifida*) was worked out after an examination of two thousand leaves. An opportunity for some thorough microscopic work was offered in the "Pollen of Ten Kinds of Flowers," and it brought out the difference existing in pollen of the same species as well as contrasts between the fertilizing dust of widely separated orders. "Thickness of Leaves" and the "Polarity in the Compass-Plant" were two topics varying widely in their treatment, one being a general and the other a special topic upon foliage. The "Time required for the Ripening of Seed" was determined in an experimental way. Blossoms of various plants were marked with twine and watched until seeds from them matured. Common purslane required ten days; the cultivated species of the same genus, (*Portulacca grandiflora*) needed fifteen days, while three times as long was insufficient time for maturing the seeds of *Euphorbia hypericæfolia*. "The Number of Seeds upon Three Kinds of Weeds" was determined as follows: common dock, 7,556;

black mustard, 16,416; and burdock, 36,456. The plants chosen were all average ones. A "Flora of a Stubble-Field" was that of a few acres where oats had grown. The *Compositæ* and *Gramineæ* orders were represented by the largest number of species, and furnished by far the greatest percentage of specimens. Two species of rag-weed and the foxtail grass covered four fifths of the field. However, thirty-five species in sixteen orders were represented. Many of these matured their seeds before September 17th, and nearly all before October 10th. Leaves of young, rapidly growing shoots were compared with those of slow-growing branches of old trees, and gave a good idea of the variability of foliage within the same species, or even the same shrub or tree. "Unequal-lobed Leaves" furnished a topic for the study of seeming irregularity, which is, however, a comparatively constant peculiarity in some species. The time of "Opening and Closing of Flowers"; "Dispersion of Seeds, a Comparative Study of Two Labiate Flowers"; "Five Largest Wild Flowers," "Are our Weeds mostly Annuals?" "Anatomy of the Milkweed (*Asclepias*) Flower," and "Sensitive Stamens of Purslane," are other topics studied by the class, the results of which were none the less interesting because the length of this paper forbids particular mention of each.

To hold each student to an examination upon the work of all these topics of research was not feasible, therefore the notes taken by each member of the class upon the reports of all others were inspected. This secured a record for each student of all the important features brought out under the topics of research, and also furnished a basis for a class-mark as required by college law.

The closing exercise of the term was upon anatomy. A brief outline of the work done in the laboratory is given below. In way of preface it should be said that the students were entirely unacquainted with the compound microscope at the beginning of the term. The first day was spent in learning how to manipulate the instrument, cut thin sections, etc. The brittle stems of the common purslane are excellent for beginners to practice upon with the razor or scalpel. For the second day pollen of several kinds was studied, and ovaries in transverse and longitudinal sections. Accurate drawings are required of all prescribed work. The flower of the large thistle (*Cnicus altissimus*) filled the third afternoon. On the fourth day the stem of richweed (*Pilea pumila*) was studied. This subject is highly recommended to all instructors in vegetable anatomy who have not tried it. The course of each bundle is clearly seen from the outside of the comparatively transparent succulent stem. The duckweed (*Lemna*) is excellent for small roots and prominent root-caps, and the hairs of the squash illustrate living cells, with nucleus, nucleolus, and circulation of protoplasm. Following these, a comparative study was

made of the epidermis, including stomata of leaves of cabbage, corn, lilac, pine, and barberry. Next were studied the root-hairs on seedling clover and the stalked glands of the cup of the cup-plant (*Silphium perfoliatum*). Internal structure of leaf of stonecrop, lilac, and compass-plant were compared, followed by stem of purslane and maple (one and two years old); pine-wood, medullary rays; endogenous stem of asparagus and young corn, crystals; starch, cork, latex tubes, sieve-cells, and the mucilaginous modification of cell-walls as seen in the outer coat of the flaxseed.

This term is followed by another devoted to laboratory work of a more advanced sort, along with a course of lectures upon cryptogamic botany and vegetable physiology.

The old and, at one time, half-true belief that botany is a simple, useless, frivolous study of blossoms which the simpering girls at fashionable seminaries may be excused for calling a branch of learning, is fast passing away. It is a hopeful sign that even so plain-thinking and practical a class as our best farmers are beginning to realize that it is a pecuniary advantage to know more concerning the structure and habits of their farm-crops. They feel that there are laws which govern the improvement of their grains and fruits as well as of their cattle and sheep. In short, there is a demand for thorough instruction in all that pertains to plant-life, and the question naturally arises in the mind of the teacher, What is the best method of meeting the call made upon him for more light? Whatever the best way may be, it is hoped that the outline herein given approaches a method, pointing in the right direction—one which stimulates to deeper and more independent thought, and begets a spirit of respect for the minutest thing, and a burning love to know the truth as it is revealed in the endless book of Nature.

ARCTIC ALASKA.

By W. L. HOWARD,

ENSIGN, UNITED STATES NAVY.

IN 1882 Congress appropriated money to buy presents for the purpose of rewarding the natives of St. Lawrence Bay, northeastern Siberia. These people had been very kind to the officers and men of the United States relief-ship Rodgers, burned in that bay November, 1881, while in search of the ill-fated Jeannette, having fed and partly clothed them through a severe arctic winter. Lieutenant George M. Stoney, United States Navy, one of the officers of the Rodgers, was detailed to make the presents, and in May, 1883, took passage in the revenue-cutter Corwin with

the gifts on board. The following July they were distributed from that vessel. Continuing on her cruise, the Corwin arrived in Kotzebue Sound, northwestern Alaska. Hearing through the Indians of a great stream emptying into Hotham Inlet, Lieutenant Stoney spent two weeks in searching for this river, and ascended it far enough to ascertain that it was a stream of considerable magnitude. Upon his return, he reported his discovery to the Secretary of the Navy, and requested leave to continue its exploration. The following spring a small party, with Lieutenant Stoney in command, was sent to survey this river. They succeeded in ascending about four hundred miles, when they were obliged to return, owing to the shortness of the season.

In the spring of 1885, a fully organized and equipped expedition left San Francisco, for the purpose of completing the survey of this river and exploring northern Alaska. The party was composed of Lieutenant George M. Stoney, in command; Ensigns J. L. Purcell, M. L. Read, W. L. Howard; Past Assistant Engineer A. V. Zane; Past Assistant Surgeon F. S. Nash, and ten picked men. A vessel was chartered to land the party, with provisions for two years, at Hotham Inlet. The expedition sailed May 3d, and reached the inlet July 12th, where everything was safely landed, and the vessel returned. A small stern-wheel steamer had been built in San Francisco, and carried on the schooner's deck, together with a powerful steam-launch. These were to be used in transporting the party and outfit up the river. Half of the provisions were *cached* or buried at the landing-point. Only a winter's supply was carried up the river.

The boats were loaded and started up the river, leaving half of the party at the landing-point. At night the boats were secured to the river's bank, and wood was cut for the next day's run. After ascending one hundred miles, the advance party encamped and the boats returned, bringing up more stores and the remainder of the party. In this way the river was ascended three hundred miles, when the winter-quarters were established. A large log-house was built, and around it the dirt was piled to the eaves. Inside, the house was partitioned off, lined with painted canvas, and the floors covered with bear-skins. The steamer's smoke-pipe was used for a chimney. With three wood-burning stoves, there was never any difficulty in keeping the house warm, even at the lowest temperature, 70° below zero (Fahr.).

During all this time we were materially assisted by the natives, a number of whom followed up the river and built their winter huts near. They appeared very friendly and pleased with us. During the month of September a trip was made to the neighboring mountains. The party, consisting of two white men and three Indians, left in a large skin-boat, taking five dogs and pro-

visions for ten days. The dogs were for the purpose of tracking, the Indian method of traveling in summer, and the only way the river can be ascended, on account of its rapid current. In tracking, the dogs are made to pull the boat by means of a long line, one end of which is secured to the boat and the other to the dogs' harness. The dogs trot along the bank, the boat being kept in the stream by a paddle astern. When the bank becomes impassable, they are taken into the boat and paddled to the other shore. After tracking two days, my companion and myself secured two natives as guides, and, leaving the river, set off for the mountains. At the end of the first day's tramp we sighted a black bear feeding upon berries about a mile distant. We were both so exhausted from our tiresome walk across the *tundra*, that we concluded to send one of the guides after the bear.

The Indian first seated himself and examined his rifle, selecting three cartridges and placing them in the gun. He then pulled a few hairs from his clothing, which he threw into the air to ascertain the direction of the wind, and then started so as to come up to leeward of the bear. We kept careful watch through a glass, and saw him on hands and knees work slowly toward the animal. When within one hundred and fifty yards, he fired two shots. The bear jumped and fell almost in his tracks.

There are probably no more superstitious people in the world than the northern Alaska Indians. Every action of their daily life is governed by some belief handed down from father to son, or originated by the *shaman*, the Indian doctor, who holds great sway over them. The ceremonies attending the killing of the bear will illustrate. Bruin was first placed upon his back, with the head toward the mountains. The head was then skinned, severed from the body, and taken by one of the natives who, placing himself astride of the dead animal, raised and lowered the head three times, touching the bear just over the heart each time, and muttering some incantation. The third time he threw it from him, uttering a loud shout, in which the other natives joined. This was done to drive the bear's spirit to the mountains, so that it would cause them no future trouble. A part of the dead animal had to be left on the spot where he was killed, or the hunters would get no deer that season. A camp was made at the place, and after the head had been roasted and picked clean it was placed in the top of a high tree, but for what purpose they would not tell. The skin was stretched flat upon the *tundra*—fur-side down. The portion of the bear not consumed was placed in a tree and a rude scarecrow made to keep away birds. The following winter the skin and meat were sledged for and found in good condition.

While tracking along the river, numbers of dead salmon were

noticed. A great many were also seen swimming sluggishly upon the surface of the water, with their dorsal fins well out, and apparently little life left. Their fins and tails all presented a stringy appearance, and were sloughing off. The natives say that these fish ascend the river but never go down; they go to the head-waters, spawn, and swim ashore to die. In our own experience, the salmon were constantly ascending the river; the later the season, the higher up they were found, and none were known to pass down. In the spring the young salmon go down and out to sea.

The valley of the Coobuck or Putnam River is about thirty miles in width. For half a mile on either bank is a heavy growth of spruce, cottonwood, and birch trees. Between this and the mountains is rolling tundra-land. The first forty-five miles of the river from the coast is the delta, with numerous lakes and marshes of various sizes, all connected by small streams, running in every direction, and communicating with numerous arms leading to the main stream. Most of the channels are too intricate to be followed. There are thirteen mouths to the river; the smallest and shoalest empties into Selewik Lake; all the others empty into Hotham Inlet. The main and most easily navigated entrance lies about one mile west of Selewik Lake. It is about fifty yards wide with twelve feet of water on the bar. Seven miles from this entrance it is eleven hundred yards wide and thirty feet deep; forty miles beyond it leads into the river proper.

The general direction of the river is westward. Its width varies from fifty to twelve hundred yards, according to the nature of the country. It is extremely tortuous, and at no place can be seen a straight course of two miles. Traces in the valley show that it has often changed its course. The current varies from three to five miles, according to the width and height of the river. Near the head-waters are rapids. The banks in places rise so gradually as to be barely noticeable, while in other places are foot-hills one hundred and fifty feet high. The river is filled with islands and has numerous tributaries.

The river freezes in October and opens in June. During the month of February the maximum thickness of ice made in twenty-four hours was four inches; the minimum, one half inch; and for the month, six feet. There is a hot spring near the river's bank about four hundred miles from its mouth. This was visited in midwinter, and its temperature found to be 100° above zero, the temperature of the surrounding atmosphere being 50° below zero. The natives state that it is so hot at times that meat can be cooked in it.

Winter is the only season in which one can travel in the interior of northern Alaska. The marshy *tundra* is then frozen and covered with snow, making it possible to cross. The natives kill

their game and do their hunting and trapping during this season. In the summer they descend the rivers to the coast for the purpose of meeting the whalers and traders, and bartering the furs caught during the winter. The principal furs of the interior are the black and silver-gray fox-skins, black and brown bear, wolf, lynx, beaver, otter, and numerous smaller skins, as marten, ermine, etc. For these skins the Indians receive in exchange powder and lead, tobacco, cotton drilling, and various small articles. Rifles are highly prized, and, although they are contraband, nearly every Indian possesses one. Deer are caught in great numbers, but their skins are valuable only among the natives for clothing.

A deer-hunt which we witnessed was so different from our previous conceptions that I think it worthy a description. Upon this occasion, while sledging with a party of Indians, a herd of deer was sighted. The natives took their rifles and started, some going in one direction and some in another, but all keeping to leeward of the deer. Those who went directly toward the herd waited until the others had got partly around before starting. The first shot was the signal, whereupon all hands rushed toward the frightened animals, who separated and plunged blindly in every direction. The Indians shouted, making all the noise possible, the fleeing animals in their fear mistaking Indians for deer, and rushing on until a shot showed them their error, when they would turn and flee as blindly as before. Even after the first fright they circled around the danger, trying to get together, and in this way many more were killed. As much meat as could be carried was loaded upon the sleds, while the remainder was *cached* in the snow, to be sledged for at some future time.

The Indians spend their winters in the mountains. They are generally found in villages consisting of from two to a dozen houses. The winter house of these people consists of a hemispherically shaped hut, made by bending willow saplings or cutting spruce to the desired shape. The framework is covered with brush, and over this dried moss and turf to the depth of a foot or more. There is an ice-window on either side of the entrance. In the roof is a hole just over the fireplace for the smoke. Inside, the center of the hut is used as the fireplace, the fire being made the same as in the open air. At the back of the hut is a meat-stand, upon which several hundred pounds of deer-meat are kept, so that a quantity will be on hand sufficiently thawed for use. Upon entering a hut when traveling, some of this partially thawed meat is always offered to the new-comer. The floor of the hut is covered with brush, upon which they sit during the day, and spread skins to sleep upon at night. Meat is cooked but once a day. About 5 P. M. a large fire is started and the pots are put on. These are the ordinary kettles of civilization which they get in trade, or, in

their absence, pots made of native clay are used The cooking is done by the women, who taste the meat from the moment it is put on the fire until cooked. The remainder of the fire is then thrown out through the hole in the roof by the young men, and, as soon as the hut is clear of smoke, the flap that covers the chimney-hole is hauled over for the night. The hunters return usually about this time of the day, and upon entering the hut take off most of their clothes. After eating pounds of the deer-meat, alternating the cooked with raw meat, and drinking quantities of the soup, they smoke a pipe, and all hands go to sleep. All the household are fond of stripping and baking themselves before the fire, particularly the old people, who go so close as to almost blister themselves. They say the heat makes them young, and drives away their pains.

The deer are not usually hunted as in the manner just described, but are killed in the following fashion: For miles before arriving at a village, long rows of stakes were noticed stuck in the snow. They consisted of bushes about six feet high, and were placed about fifty feet apart. Against the white background they give the appearance of a man. Two lines of these bushes are made, their outer extremities a mile apart. The lines gradually converge, so as to form a lane. At the end of this lane is a corral, built of brush and wood, through which a deer can not penetrate. The brush is hung with nooses to catch the animals should they attempt to pierce the confines. A herd of deer being sighted, they are driven by the natives toward the entrance of this trap. The deer flee from one side of the lane to the other, mistaking the bushes for men, and finally enter the corral, where they are killed with bow and arrow. Hundreds are killed every season in these traps.

The first of December, as there was then plenty of snow on the ground, the sledging-trips commenced. I had looked forward to them, anticipating a great deal of pleasure. My idea of sledging was based upon a half-forgotten picture in an old school atlas, representing a man dressed in furs comfortably seated upon a sled, brandishing a long whip over six dogs in front, all on a trot.

The first thing to be considered upon preparing for a sledging-trip is the question of provisions—for both party and dogs—cooking-utensils, clothing, tent, and numerous smaller articles, until the prospect of comfortably tucking one's self in a robe on the sled looks very much like riding upon the hump of a camel. At least two persons are necessary in the management of a sled: one to run ahead for the dogs to follow, and the other to remain with and guide the vehicle. The dogs will follow a beaten path, but in crossing the trackless country it is always necessary to have a runner ahead. The sleds were loaded so heavily that all thought of rid-

ing was given up, and in less than a mile from the starting-point all hands were upon snow-shoes. These shoes are from three to five feet in length, bowed and curved upward at the toes, and tapering to a point behind. In the center are thongs upon which the foot rests. They are secured to the feet by two thongs crossing just forward of the instep, passing around the heel, and attached to the shoe near the toes. This gives the foot full play, and enables one to rise upon the ball of the foot, as in walking, and shove the shoe forward over the snow instead of lifting it. It is very easy to walk a short distance, but, when running after a sled over the uneven country, the tendency of the shoes to rise is equal to that of a pair of roller-skates upon the feet of a novice.

The first sledging-trip was to the northward. At 4 P. M., after a hard day's march, a camp was established, it being then too dark to travel. The dogs are first unharnessed, and chained separately to bushes, to prevent fighting. After an hour's rest they are fed upon dried fish, this being the only meal they receive in twenty-four hours. They are given all they can eat unless the supply is short, and in such cases their endurance is wonderful, a small piece of fish once a day sufficing a dog and enabling him to work for a couple of weeks. A great many interesting facts could be given illustrating the sagacity and endurance of these animals. As a rule, they have no affection. They recognize the person who feeds them as their master, but they obey only through fear. They are more than half wolf, as all young wolves caught are raised and used as dogs. In every team there is generally one dog who constitutes himself master. He is naturally one of the most powerful of the number, and the others seem to recognize his supremacy. This dog, upon seeing any one of the others habitually shirking while the rest are pulling, will attempt to reach and punish him, and if it is impossible to do so while in harness, will deliberately go to him when the day's sledging is finished and administer the deserved chastisement.

In establishing a night-camp when in a wooded country, the most sheltered spot is selected and a pit is dug in the snow about fifteen feet in diameter and a foot deep. The bottom is then stamped down to make a hard floor. Around this pit is built a wall about four feet high, by laying young spruce-trees on top of one another and cutting off their inside branches. This wall has two openings or breaks diametrically opposed, dividing the pit into halves with a through passage-way separating them. Along this way, which must always face the wind, dried wood is piled and fired. On either side pine-boughs are laid on the snow, and on top of them the sleeping-bags. Such night-camps are easily made, and the coldest nights can be comfortably passed in them. The only drawback is the difficulty in getting wood.

After a nine days' trip the village of Nimyuk, the highest settlement on the "No Talk" or Inland River, was reached. This village consisted of four huts, containing thirty inhabitants. They subsist almost exclusively upon deer-meat, of which they had at least two thousand pounds on hand. The day of our arrival thirteen deer were killed, and in some of the *caches* were as many as thirty. We were greatly annoyed by the curiosity of these people, some of whom had never seen white men before, and by their superstitions. As it was their dancing season, no meat could be cut with an axe, and we were compelled to saw up a frozen deer —a difficult task. Neither could any meat be cooked in the house nor tea drawn. The work had to be done outside, and the things passed through the chimney-hole. These fancies are persisted in, in the belief that to do otherwise would drive the deer from the mountains. In some instances their superstitions can be overcome by the payment of a bribe.

On the 12th of April the writer of this article started on a trip across the country, the object being to reach the arctic coast if possible, and thus penetrate a portion of the Territory never crossed before. Previous to this I had made two trips one hundred miles to the northward, and *cached* dog-food for use on the final journey. I took with me at starting one white man, two Indians, fifteen dogs, and two sleds, and all the provisions the sleds could carry. The snow had commenced melting at midday, but at midnight the temperature fell as low as 25° below zero. A week's travel brought me to the village whose inhabitants make the trip to the arctic coast. As I intended journeying with these natives, one sled and the two Indians were sent back to the winter station. Many attempts were made during the winter to induce these people to cross this northern region, but they could not be tempted, saying it was impossible on account of the cold and scarcity of food. Northern Alaska can only be crossed at two seasons of the year: in the spring just before the rivers break up, and in the fall just as they close. The deer leave the mountains at these seasons and cross, thus settling the question of food. A few of the most interesting facts observed upon this trip are briefly related, as follows:

On May 1st twenty sleds left the village in the mountains on their annual visit to the coast. This caravan, stretching out over half a mile of country, presented a peculiar spectacle, men, women, children, and dogs all pulling at sleds. When an Indian travels he carries all his possessions with him. Everybody was upon snowshoes, and numerous stops had to be made to allow the old people to catch up. During this trip an addition was made to the party in the person of a baby boy born on the march. One noon, while the caravan halted, some Indians hollowed a shelter out of a

snow-drift, and put in a couple of deer-skins. The sleds then started on, leaving the prospective mother behind alone. That evening the mother and child came into camp, the woman having given birth to the child and walked several miles. While traveling the next day the woman had hard work keeping up, and, upon passing her as she rested in the snow, I offered her a seat upon my sled, but the others would not allow her to ride. Also, in cooking, she was compelled to make her own fire and cook alone, for she could not drink from the same cup as the others; and there were numerous other absurdities. According to their superstitions, the non-observance of these customs would result in misfortune to the child.

After a week's hard sledging the head-waters of the Kunyanook or Colville River were reached. Here all hands encamped near the site of an old village, and preparations were made for spending several days. Part of the caravan were to remain at this place until the river broke up, and then make the remainder of the distance in boats. This point was the highest on the river that the natives could reach in boats. They ascend here in the fall and wait for the snow to come to enable them to sledge to the mountains. The boats are stripped, the skins which form their covering being buried until the next season, and the frames placed high up on racks to prevent wild animals from reaching them and eating the lashings. In the spring they sledge from the mountains to the boats, where they wait for the river to break up and thence descend to the coast. This practice is general with all the interior natives.

After resting three days at this village the journey was resumed, only six sleds going on. The Indians told of another river farther to the westward, and I concluded to accompany them to find this new river. After sledging upon the Colville six days, that river was left, and a range of hills about five hundred feet high crossed, bringing us to the Ik-pik-puk, the Indian name of the new river. These hills form the northern limit of the mountains of Alaska. On one side is the Colville, which here makes a sudden bend to the eastward; on the other the Ik-pik-puk finds its head-waters. Proceeding farther north, the country gradually becomes more and more level, until, for the last fifty miles from the arctic coast, it is perfectly flat, with no elevation, and is so full of lakes, marshes, and rivers that it is impossible to walk any distance in a given direction. In crossing this section we could gather no fuel of any kind, and our food had to be eaten uncooked; but this fact did not trouble the natives. The greater part of the time we had no food, and our diet consisted mainly of a succulent root growing in the marshes, which the natives gather in quantities, depending upon it when other resources fail.

A camp was made at the head-waters of the Ik-pik-puk, and runners were sent ahead to the village below to announce our arrival—this being the usual custom. Early the next morning dogs came to help our worn-out animals, and at noon we reached the village, where one hundred and fifty Indians were encamped waiting for the river to break up. We had evidently been expected—a place having been reserved for us—and while the new-comers rested, the women unharnessed and fed the dogs, pitched our tents, and prepared food. In the center of the village was a great dance-house, where the men gathered to work during the day, and dance at night. They are very fond of this amusement, sometimes continuing it the night through. Some of the dances are pretty, the motions being graceful, but they soon become monotonous. The music is produced by from four to ten "tom-toms," upon which they beat time, while shouting at the top of their voices a rude monotone. Men, women, and children all dance—often continuing until they drop from exhaustion. The first things taught children are to dance, shoot the bow and arrow, and to smoke. It is a common occurrence to see a mother take the child from her breast and give it her pipe.

At this time—the last of May—we had quantities of berries. They had ripened during the last season; the snow had preserved them through the winter, and was now melting sufficiently to expose the bushes. While waiting for the river to break up, the men busied themselves in repairing the old and making new boat-frames. Their boats are of two kinds: the *kayak*, or one-man boat, and the *oomiak*, a large boat capable of carrying a ton. The frames for these boats are whittled entirely by hand. After they are thus made and fitted, they are securely lashed with whalebone strips, and are then ready for their covers. The *oomiaks* are covered with seal or walrus skins, five to seven of which form a cover. The *kayaks* are covered with deer-skin, the skins being first soaked and scraped. These covers, which had been *cached* all winter, were now taken out and buried beneath the melting snow, to render them soft and pliable.

The women were busy currying deer-skins for clothing, and making twine for fish-nets. The native tanning consists of scraping the dried skin thoroughly with an instrument made by putting a piece of flint-rock in a wooden handle, so curved as to fit the hand perfectly. The stone is chipped at one end, so as to make a rough, sharp edge. After scraping, it is rubbed with a soft stone resembling pumice, which whitens and softens it. The finished skin looks and feels like chamois. The twine with which they sew is made from the sinews of the deer, which are dried and torn in shreds, and these are twisted together, making a very strong cord. This is used for making nets also, any required strength

being given by using larger shreds. The only disadvantage in using it is, that the nets and lines must be taken from the water and dried frequently to prevent rotting. A stout line is made by cutting a deer-skin in one continuous strip, about one quarter-inch wide. The stoutest line—used in tracking—is made in the same way from walrus-hide.

The river broke up June 3d, and on the 8th five *oomiaks* left the village. After an interval of two days, five more left, and so on, the country not furnishing enough food for all to go in a body. June 27th the arctic coast was reached. The river proved to be about two hundred and fifty miles in length, and enters the Arctic Ocean about forty miles to the eastward of Point Barrow. While floating this distance, I procured two mammoth-tusks, weighing about one hundred and fifty pounds each, and twelve feet in length. Every spring the river rises and washes away the icy earth forming its banks, thus exposing fresh surface. These tusks are found firmly imbedded in the ice. Three of them were exposed that season.

I was detained on the arctic coast from June 27th to July 16th, waiting for the ice to break up sufficiently to enable us to make our way inside of the heavy ice to Point Barrow. The northern shore of Alaska is extremely shallow and sandy, great sand-spits being shoved up by the ice all along the coast. The beach is covered with drift-wood, which comes from the rivers emptying into Behring Sea. In conclusion, the Indians of Alaska have been reported as savage and treacherous. In my experience, I found the natives of interior northern Alaska the most kind and hospitable people in the world.

MANUAL OR INDUSTRIAL TRAINING.

By Prof. G. VON TAUBE.

CIVILIZATION means economical foresight and the gradual subserviency of present selfish interests to the good of others in the future. True civilization begins only, then, when a new potential factor is recognized as worth striving for, to wit, the coming race and its future welfare. Emotionally we revive in our children; economically we sacrifice many of our present gratifications to the development of the race. True educational striving aims beyond the narrow view of the future career of a few beloved ones; it recognizes in the school-bench an economical measure of social security more powerful and efficient than drilled regiments, squads of policemen—yea, than well-organized dispensations of charity. True educational measures, therefore, grow

with us in their every-day importance; and their power of molding social conditions once recognized, the very important query may be considered if they could not be possibly so improved as to secure to the average individual means of subsistence outside of his general culture and the acknowledged moral improvement resulting from it.

Adaptation of general training to the presumable needs and wants of the individual, rather than to his social requirements, is the programme of the new education that has already modified the old-school routine through the introduction of the psychological basis, and which now proposes manual training as one more step forward. Tried on purely empirical bases, many inductions have been arrived at; still, a general deduction is yet wanted, before the measure proposed would be worthy of a true pedagogical interest.

The pleas for manual training as an educational measure are many, and as the methods employed in instruction must necessarily depend upon the end expected, it may not be amiss to examine at least the leading theories.

Such a critique, nevertheless, based upon the campaign words, if we may so call them, of the different advocates, in the absence of a full exposition of their views, must be made rather in the form of suggestion than otherwise. Thus, the first purpose encountered is that of the *development of perceptions.* One would assume a psychological basis, if the age of the pupil corresponded with the programme in view; but in the present application perceptions mean sharpness of the sensorium, the first stage of mental growth in the child, generally expected to have been accomplished in the Kindergarten; afterward objective teaching in the elements of natural sciences, aided by collections, etc., would do just as well, and, moreover, would produce as a beneficial result certain general knowledge not obtainable from the simple manipulation of tools.

2. "The use of the hand and brain" is a general figure that is certain to be found on every page treating of industrial training. It would do very well indeed if the brains were necessarily taken into co-operation; but such a general programme depends too much upon the system employed. It will be found entirely unsatisfactory if the means applied be confined to a so-called series of graded exercises in wood or metal work — say cross-cut, rip-saw, nailing, gauging, squaring, etc.—followed, as they generally are, by the x y number of joints about the practical use of which the pupil generally remains in the dark. Brains, if considered independently from their owner, are too apt to be subject to the general law of inertia, and the whole occupation may simply be reduced to an automatic mechanism, especially if it is connected

with the good old style of disciplinary measures: "No. 1, 3, 5, 7, 9, etc., stand back! No. 2, 4, 6, 8, 10, etc., step forward! Hands folded! Hands up! Hands down, down! March!!!" etc. A workshop of children silently and mechanically performing certain motions with their hands, produces too much the impression of one of the state institutions for the correction of the young, not exactly credited with having produced such geniuses of thought and action as the Nasmyths, the Whitworths, the Goodyears, the Edisons, and others.

3. Manual training continues the work of the Kindergarten, which, of course, presupposes the full knowledge and solution of that problem. The pupil, nevertheless, has by that time outgrown childhood, and unless one imagines a uniformity in the mentality of mankind from seven to seventy years of age, some different stage of intellectual development is reached, and though continuing the Kindergarten, another work, psychologically speaking, is expected, the explanation of which is still to come. Then follows a whole series of claims set forth under the large and benevolent mantle of Industry. We begin with the sewing class and the agricultural Kindergarten, with the fields in a box four feet by five feet, minute plows, harrows, spades, etc. Scroll-work, taken from Krüsi's series of drawing-lessons, something like three hundred sketches of pitchers, vases, chairs, brooms, crescents, etc., all cut out to impress the idea of form upon the patient mechanic. Then innumerable pieces of wood, worked with the jackknife only. Plaster relief-maps, giving half an inch height to the poor Cordilleras, the whole of South America represented in six by nine inches, etc. Things valuable indeed in their way, but not warranting, as general educational measures, any outlay of state money.

Further, again comes the instruction in the use of the seven tools—adze, plane, hammer, drill, chisel, saw, gauge, etc. This at last sounds more serious and comprehensive, but still remains unpromising, if it stops there, and, unluckily, one does not have a chance to hear what is to follow. Such exercises may be carried out very successfully, experimental as they are in colleges, alongside of a full allowance of theoretical mechanics; but they are by no means the Alpha and Omega of manual training in a common school. Finally, we have a series of trades with their gamuts of so-called elements, wood-work, modeling in clay, metal, and stone work, etc., representing a dozen or so of trades, the elements of which are expected to be mastered. No one can deny a practical side to this programme, only it is apt to embrace either too little or too much.

The enthusiastic statement of the advocates of this system, that the ground principles of any trade are practically learned in

any particular number of lessons, appears too sanguine altogether if compared with actual reality. It is true that a given number of lessons of practical instruction in the tool-house may give quite a broad understanding of the elements of the trade to students conversant with its theoretical knowledge; but such is not granted, and hardly possible, in the case spoken of. Theoretical mechanics calls for its quota of higher mathematics, which is here outside of the question. Practically, then, we run the risk of turning out Jacks of all trades and masters of none. The pupil graduating from any of these departments will in the best of cases be an indifferent artisan. He will certainly have acquired an acquaintance with tools, and will possess considerable insight into the special arts, but empirical, detached, and uncorrelated as his knowledge would be about the processes, the habitual routine, a good portion of life's experience, will be still wanted to make him a desirable article in the industrial market. Besides, although it unmistakably would increase the efficiency of our workingmen, public schools can not be converted into special trade schools. Thus it is clear that the field is open as yet for a theory and practice in industrial training, which, taking hold of the necessities felt, and basing a system of instruction upon a rational method of analysis of the age of the pupil and his other educational requirements, would suggest a method that would finally bring the discipline within the ranks of serious educational measures.

The understanding of the cause of a given movement is almost equivalent to the mastery of the movement. Considering the increased interest in industrial training, one can perceive in it the reaction of two great demands for change and relief—to wit, the economical industrial, and the educational proper. In industry, the world, propelled by the advance in knowledge of natural sciences, has outgrown the old apprentice system. Sciences applied have made the old trade secrets a tradition of the past. The multiplicity of machinery has made the special skill of handwork, previously so important, only a secondary consideration; it has also occasioned a subdivision of labor so definite and minute, as apparently to make even the special knowledge of a whole trade not indispensable, so long as a workingman may simply be continually employed to attend to some special machine. The result of such industrial development, considered from that point of view, has only diminished the need of personal initiative, and gradually changed the "previous master of tools into the tool of a machine." New patents, improvements in process or machinery, introduction of new devices, so frequent in industry to-day, have diminished also the permanency of employment. A special worker or feeder on $x\ y$ patent machine becomes obsolete as soon as $x'\ y'$ replace the previously used $x\ y$; and, one-sidedly

trained, as he generally is, hardly capable of immediate satisfactory work on the improved plan, our poor fellow is thrown out of employment; he generally undergoes untold misery and suffering before being employed at something else. Of course, strikes and other labor combinations may, to a certain extent, extort from capital some extra allowances. Organized labor may command a higher price, may even go so far as to form an insurance fund for the unemployed; but neither legislation nor organization will ever root out the evil, because they do not destroy its cause. After all, out of the total capital employed in the industry of a given country, there is only a certain percentage to be spent in wages. As soon as capital can not obtain its economical due, it flows into other channels, often outside of the country itself; and as there is no friction possible without material wasted, it is for a short time only, economically speaking, that there can be found an apparent redress for labor through the terrorism of labor. Ultimately it will turn out against it, as the stoppage in the industrial wheel occasions a loss to capital and labor that both are sure to feel, and which generally is felt more harshly by labor.

Co-operation is a magnificent theory; indeed, it reminds one of the golden age; but, practically speaking, it will, like any other scheme, be subject to considerations of profit and of remuneration, *pro rata* of the intellect, work, and capital (money) employed; and no ism, notwithstanding its popularity, or even its majorities, will destroy this horrible *pro rata* distribution. Besides, any co-operative scheme needs genuine abilities, not found in a fossilized mentality of a one-sided training and more than one-sided occupation. The change demanded, therefore, has to be of another nature than can be brought about by organization, legislation, isms, etc., which by their very presence eventually demonstrate the necessity of a change. It has to go deeper; its workings will be a matter of the future rather, and the result of a systematic and well-calculated movement in the right direction. It simply aims at a regeneration of our workingmen of the future.

An educational regeneration, an increase of their capacities, their initiative, their artistic taste, and their power of invention—such elements, once present, would augment the value of our industrial products. They would allow us successfully to compete in the foreign markets, not by lowering prices, but by the superiority of our articles in quality, durability, finish, and elegance of design, and would thus increase and not diminish the share of wages. France, England, Germany, even Russia, have actually accomplished this by introducing schools of design, modeling, etc., alongside of their various special industrial centers; but France and England had their traditional specialties centuries old. In this country, with so many more industrial facilities, with so

many more possibilities for diversified specialties, we want more than schools of ornament, good as such may be. Unable to compete with the low prices of European or Indian manual labor, we leave it to our machinery, and expect our workingman to enable us to enhance the value of our articles by the helping presence of industrial brains and knowledge, so important and generally better paid than manual labor alone, and for that result we look to industrial training as a means.

So much for the economical consideration, now as to pedagogics proper:

Education, the fitting for life. Life, unless your father is a millionaire, and does not spend or lose his millions before he dies, sums up practically in an activity in some profession, an activity aiming at a decent self-sustenance; professions outside of poetry and art, the inspirations and special proclivities of which we will not discuss. Professions may be summed up as clerical, legal, and literary or scientific. We have unmistakably succeeded in perfecting the training preparatory for some of them, and, as it stands to-day, defy any European institution to supply accomplished clergymen or lawyers in a shorter time and at less expense. Literary men escape our arguments for the same reason as artists and poets.

Clergymen we want, in order to maintain the phase of culture and the methods of thought which it is their function to care for. Lawyers can do no harm, even if there should be too many of them, as law well understood by the greatest number in the community is a safeguard against the thrilling and dramatic in public life, an element not exactly in demand; besides that, a lawyer can always do good service in legislation; but how is it about our mainspring as a nation, our technical and scientific men? Gain, pleasure, or respectability, directly connected with a special branch or pursuit, makes one or another profession more or less desirable. Inductive knowledge has recently made gigantic strides. Scientific knowledge has acted as the great lever of respectabilities. The traditional liberal education is but a phantom of the past, and the parlor accomplishments of the old, refined type, lightly glancing over the poetical, the artistic, the ideal of human nature, etc., is slowly but surely making way for the less voluble but more serious and practical gifts of the thinking individual of modern times. Scientific culture is already recognized as an equivalent of the literary, if not its superior. Slowly but surely, the sciences have gained their due places, and an ignoramus alone would refuse to credit them with the motive power of our advance in civilization. Scientific professions, therefore, would be found desirable and respectable to-day as a specialty in the liberal arts so called. This granted, let us approach the subject

more nearly. Based on actual experience, the methods now prevalent in sciences are inductive, and call for experimental work as indispensable. Scientific knowledge of to-day may be said to begin its inquiries with an experiment, and to prove the correctness of its conclusions by another. A facility of manipulation, therefore, the aptitude for laboratory work is all-important, and this may be found by analysis not to be the result, as it is often popularly accepted, of natural or inborn talent, etc., but to represent a special training, a special knowledge, thus:

1. We expect a well-developed perceptive power in the senses, delicacy of touch, a minutely trained eye, ear—yes, even nose.

2. A steadiness of purpose, and a patience understood only by those who have worked on the same problem repeatedly and unsuccessfully, often for weeks, before they could obtain the desired results.

3. A synthetic initiative in putting things together, a laboratory intuition, so to speak, which, like any other intuition, merely represents an unconscious storage of the data of numerous antecedent trials and attempts.

4. A knowledge of the nature of materials employed, say those that we may justly call materials of construction.

5. Knowledge of the elementary laws in sciences, some mechanics, some chemistry, to be afterward supplemented by the adequate systematic study of mathematics and the philosophical analysis of theories.

Such, in short, are the prerequisites for a modern scientific apprenticeship, and such a preparatory training, both in knowledge and manipulation or practical work, is expected to result from the innovation recommended—the industrial training or the experimental laboratory connected with every technical fitting-school.

Within the writer's memory, instruction in sciences has been entirely revolutionized in its methods. It was suffering from the traditional scholasticism and its influence, modernized into that terrible bugbear the classical languages. Definitions learned by rote used to mark the first hard steps of the embryo engineer, geologist, or chemist, etc. Definitions numbered by the hundred then, of which very few have withstood the test of time, most of them having vanished with Torricelli's vacuum theory, etc.

A boy might then have had all the qualifications that we would look for to-day for a future scientist. He might have had a deep interest in any mechanical contrivance—for instance, taken watches apart and put them together, picked out all the needles out of his mother's drawer with a magnet, have been enthusiastic about a horse-power, say a thrashing-machine, or have successfully, although with some slight mishap, tried the properties of gunpowder, of sulphur, of phosphorus. The little fellow may have

been seen standing for hours before that mysterious automaton, a steam-engine, his little body unconsciously following the motion of the fly-wheel, his eyes fixed intensely upon the valves or gears. On inquiry he may have given you satisfactory explanations about the working of the engine, describing minutely its parts and the way they are put together, information that he had acquired incidentally and all by himself; and yet the same boy, after a year or so in the school, would have often been pronounced a dunce by his learned teacher, and specially without any love for natural sciences. Why? Simply on account of his inability to recite correctly the generally incorrect definitions. Many a bright school companion of the writer, having in him all the material wanted to make a splendid technical student or scientist, became a classical literary nobody on account of *the definitions*. Then, again, what a horrible crime, was it not, to have dirty and lacerated fingers, resulting from some little galvanoplastics or the like! "So ungentlemanly" was another time-honored intellectual obstruction. It may have saved a few dollars' worth of clothes, and even taught some so-called respectability to the boy, but it killed many a good brain.

Gradually, nevertheless, things began to change; actual experiments began to accompany the horrid book of definitions. It is true the teacher, himself generally a very inefficient practical worker, kept all the apparatus locked up, and only on extra occasions was the glass closet opened; but then, what a joy! what an interest! what a number of never-ending questions! When of a sudden down came the marks for noise, disrespect toward the teacher, speaking without permission, and so on. The presence, however, of the apparatus, even behind the glass doors of the closet, strongly contributed to the general interest in the matter. How eagerly did we not study our abhorred definitions and work for good marks, so as to have the privilege of taking out the apparatus from the closet!

In college the collection was more complete, and you had even the right to touch the apparatus, although the teacher alone performed the experiments. Soon, however, came the greatest and the most charming of innovations, laboratory experimental work, and finally regular laboratory instruction, when of a sudden—eyes did not see, nose refused to smell, in chemistry; fingers were found clumsy and the dimensions badly guessed at in physics. Broken glass without end, cut fingers innumerable, miserable experience with the apparatus, that generally refused to work, discouraged many a scholar, especially if the not always good-humored professor or his assistant repeatedly pronounced the melancholy decree: "You will never accomplish anything, Mr. So-and-so. You can not see, you do not smell, you do not recog-

nize the difference between this precipitate and that other. Do you think that you ever will be a chemist, sir? An illusion, sir, an illusion, a sad one; waste of time and your father's money; better take a course in theology or judicial jurisprudence." Well, many such an illustration may be real to-day also. It is true we have gone a step further since; we have now in most of the colleges that respect themselves physical laboratories, generally well mounted; here instruction is received and practice is obtained in scales, dimensions, standard units, etc. But what would have been a heaven for the twelve or thirteen years old boy becomes only too often the place of torture for the nineteen, twenty, or twenty-one years old young man; unsuccessful in his attempts, clumsy because not trained beforehand, he often wishes the whole recitation to forgetfulness; and a large number of students remain afterward mere designers in technical offices or poor lecturers on the so-called popular sciences, instead of following a successful scientific career, doing original work, and possibly realizing discoveries, improvements, wealth, and honor. The many failures here ought to serve as an emphatically practical lesson on the necessity of adapting work to age.

When the young man enters the laboratory at college, he ought not to encounter any mechanical difficulties. His attention ought to be chiefly directed to more abstract thoughts, to his theories, his laws, etc. Expert with his fingers, his senses trained, he ought to be able to note differences and similarities in the experimental phenomena, formulate his hypotheses about them, and verify them. Very recently the writer had a good chance of seeing the above practically illustrated. The son of one of our leading citizens, entering his second year in Princeton, who had just the training (tool-house work) recommended, was present at the recitation in physics; a fine apparatus was brought in and the professor had some trouble in explaining to the class the working of the micrometer-screws in the apparatus—in other words, the way the principle of the micrometer-screws is practically applied. The writer's acquaintance, handling the screw in his turn, suggested to the professor the possibility of doubling the delicacy of the scale by letting in another screw within the first, a suggestion that was willingly accepted, and as far as he knows executed. The older young man wants as the basis of enthusiastic exertion, a higher generally practical purpose than merely the routine of manipulation, or the preceding wood and metal work found in some colleges; besides, he hardly has any time for it; of course, he submits, but generally, in direct ratio to his intellectual development, he gets disgusted with the practical drudgery. At that age there is a restlessness of mind, a flight of imagination, an elasticity of thought, that can and ought to be utilized more ad-

vantageously than the training of the hand and eye principle. This, as we saw, belongs duly to the fitting-school and not the college.

Thus sciences are found to-day to call for an adequate elementary preparation, and this one requires, as we have seen, an adequate training of the senses to be begun at the natural age alongside of certain elements of knowledge. It is ridiculous to expect that such a minutely specialized field as that covered by the sciences to-day should suddenly be successfully approached by some mysterious roundabout way, and through the study, say, of Roman antiquities and the like, which have no bearing whatsoever either on the theory or practice of sciences or on the inductive reasoning found so important in these branches. Detached facts, with which you have to begin, may be easily seized and remembered by a boy of twelve, but they escape the mnemonic power of a young man from college; and if collegiate higher instruction is to bring fruits and actual results, its higher working must be free from elementary difficulties. We do not expect a young man who had not mastered arithmetic to begin calculus; and there is just as much discrepancy between atomic theory, specific heats, etc., and the experiments of the burning of a candle, hydrogen and oxygen generation, the piece of chalk and vinegar, etc.

So far, then, the future of industrial interests at large demands a general practical preparation replacing the old apprentice system. It is claimed for such a system that it would enable the workingman, through the command of adequate knowledge, to become free from his present bondage, and make him again the master, instead of the tool—not of capital, as some socialist friends would declare, but of his true superior and master, the powerful automaton, the machine. On the other hand, we find also a similar necessity claimed by the scientific professions. Equally with other concerns, one can but recognize that agricultural interests could be fully benefited only by the measure recommended, and that the business part of the population would hardly lose their time spent in training, as specialization in industry calls for an adequate specialization in business. Some general kind of technical or industrial knowledge would be easily appreciated by any business man, either behind his desk, in selling and buying, or in his leisure hours at home, where it would be found a valuable source of healthy exercise and recreation. The omnivalence, therefore, of manual or industrial training once granted, its methods may be now approached.

From the start it is evident that, instead of forming the additional fifth wheel of our pedagogical vehicle, the measure spoken of is entitled probably to a good half of the total traction.

Equally self-evident it will appear that, instead of representing only an additional exercise, separated from the rest of the instruction, perfect correlation with the same has to be established, if anything like serious results or benefits are to be expected. In other words, manual or industrial training can be summed up as the experimental adjunct of the abstract studies, verifying the correctness of the conclusions arrived at, in the shape of laws, theories, or principles, and demonstrating their practical adaptability. A pupil having some idea about the actual use of the things he learns is, without comparison, the superior of one who only hopes to find it out some time at college—if ever. As, nevertheless, the curriculum of a general popular, say, public-school or artisan education, varies to some extent, at least, from a preparation for a future profession, the special course in the experimental departments of the two will have to differ respectively.

Objective teaching, or the practical acquaintance with one's surroundings and Nature's chief subdivisions, will remain common to both—the value of such instruction being enhanced through the so called Socratic method of cross-questioning, but at a point of abstract concentration certain parts of the said objective instruction, say, in form and number, may in their further development form a line of demarkation. Form might lead to practical working draughts in the manual training of the first case, and number, entering here as the necessary accessory, would serve only for short immediate calculations. A more mathematical handling of the subject, subjecting facts to more minute calculations, and early introduction of the mechanical equations of cause and effect, will form the central pivot in the second higher grade of schools. Certain generally lightly treated truisms may be added in shape of suggestions to enable any worthy pedagogue to start logically in the progressive line of our educational innovation.

1. Mathematics has its origin in the concrete and not in the abstract, and therefore is more easily approached and more successfully taught on this basis. One has to start with actual things —dimensions, forms—especially when dealing with pupils of the elementary grades.

2. Space, notwithstanding Hamilton's arguments, viz., Stewart's, is conceivable to us only conjointly with the actual experience of muscular exertion; its notion originates with the turning of the eye of the new-born child and our pedimetric or other dynamic measurements.

3. Language is by no means our only agency for making ourselves understood; a few lines, if properly drawn, will tell a better story about many things in technics than a long-worded lawyer's version. The short-hand expression, sketching, is therefore an in-

dispensable grammar of its kind, found easier, more attractive, and especially more practical, than the beautiful series of definitions in honored Brown's or other memories.

4. In handling objective grades in elementary lessons on Nature, the teacher can with the same facility and with probably more profit select his illustrations in plants, stones, metals, from popular and locally well-known kinds than by rambling over the tropics, etc., for the ideal botanical or other type.

He thus introduces the essential materials of construction, and early establishes in the mind of his pupil standards of comparison, so much the more important as, taking the ease of their minute study into consideration, they can really be well and correctly understood. In physics or elementary mechanics an actual simple screw, a wheel, an axle, a real wedge, balance, etc., may be employed at that age with more benefit than the expensive micrometer apparatus. In this way a public-school pupil would finally be found in possession of considerable practical information and available knowledge. He would recognize the trees in the forest, the stones in the fields, and feel an interest in our every-day appliances, that would otherwise leave him entirely unaffected. In this way also, and connected with his arithmetic, elementary mechanics under their popular names may be successfully introduced, the pupil as well as the teacher being able to use immediately a stick for a lever, any plank for an inclined plane, any rubber or leaden pipe for a siphon, instead, as used to be the common practice in our various seats of learning, public and other, starting with the definitions of the undefinable force and matter, puzzling over Newton's laws, and finally trying, generally in vain, to remember the formulas of the p, the w, the f, etc., generally not mentally present, on account of the slight acquaintance with them. Add to this the letters, syllables, words, and sentences of our cosmopolitan short-hand, drawing, taught simultaneously with the correctly spelled vernacular, and we are ready for the exercises with tools, as every one of them is but an illustration of the principles of the now known lever, inclined plane, wedge, etc. The seven types then can be appreciated; they cease to represent simply pieces of steel. The pupil recognizes in them the material for many interesting problems requiring solution. He alternatively combines them or tries their identification in their various combinations, as presented to him by manifold machinery. He repeats the previously mentioned automatic movements; it is true, he passes through the graded series of exercises we have enumerated, but with what a difference in spirit and results! His mind, inert previously, is now full of activity, and the new kind of inertia, to which it is subject, that of motion, carries him steadily onward to future improvements and discoveries.

Passing through the systematic routine of instruction in wood-working tools, then the metal-working tools, the instruction in the materials of construction and recording his work systematically in his short-hand the drawing, the boy thus correlates things apparently detached; trains his judgment, and is fully able to supplement through self-study whatsoever special knowledge he would find desirable in a given time. Such a boy is sure not to depend for his living upon a special kind of machine. Why? Because he has learned how to understand and read machinery. The next point sure to come up, whatsoever we treat in our modern times, would be that of cost. Considering the return of very desirable and highly probable results, the outlay will be very small indeed. Some system, some logical analysis of purpose, some honesty of purpose especially, and we have it. Time and money being the chief considerations in the matter of public schools, a few suggestions may be allowable.

We are far from condemning the instruction, and far from making a crusade against the selection of branches even. Having visited educational institutions in many countries, the writer considers the American system superior to the others, and as most assuredly answering well the purpose intended. The only question is, whether that purpose is desirable. If collegiate education of a non-scientific professional character be the golden door of life's success, then the public-school system is the one wanted; but if, on the contrary, industry and commerce be accepted as the more important fields, then the system is a failure, not on account of its practice or standard, but simply as not supplying the demand. One of the most enigmatic objections against the innovation intended (emphatically), "The state has no right to prescribe the future occupation of the growing generation," sounds very decisive indeed, but has but little, if any, real bearing on the question. To answer one generalization by another, the writer may with the same weight put the following query: "Has the state the right to educate for no special occupation, although such is unavoidable in actual life? Or otherwise, has the state the right to teach the boy first that he is created with equal rights to enjoy life, to teach him what to desire, how to enjoy it, but not how to get it; and then legally crush him for having got, or at least attempted to get, the thing accepted as desirable, the best way he could? Many an educational veteran may puzzle over it.

Then, again, the argument that the instruction received has helped rather than obstructed many a case of the desired success in technical or commercial career, it may be answered that the proposed change will by no means prevent any individual from becoming a minister, a poet, a teacher, a politician, etc. On the contrary, it appears very plausible to admit that a manually

trained pupil would be more helped toward that end by his schooling than a scientist has been helped hitherto by the old routine. But if this be admitted, a considerable change of the present curriculum must follow. Thus, foreign languages in our public schools are, in the best of cases, a mythical adornment, nothing else. In exchange for the money spent for it, the amount of actual philological information is very small. The only available part of such instruction would be conversational ability, which of course can not be wisely expected as the result of the few half-hours in the week, because the detached grammatical particles of a lacerated foreign idiom most assuredly can not produce the least earthly good, and do often interfere as a bad mixture with the purity of our English. Equally so with geography and history. Taught as they are, they could with equal benefit be left out of the curriculum.

Geography is either the most valuable branch to the teacher or the most valueless for teacher and pupil both. If used as the great co-ordination means for a thorough instruction in elements of natural history, botany, geology, etc; if taken conjointly with the instruction in elementary knowledge about terrestrial atmospheric forces and their activities; if united to general information on the elements of history, beginning with some conception about man, his occupations, nature, etc.—then geography in the hands of a skillful teacher is *the branch*, is, so to say, the mnemonic key of general information, as without localization any information is of questionable value. But if representing simply detached memory exercises of so and so many hundreds of foreign names, etc., sure to be forgotten before the pupil is through with the book, then, of course, it is waste of time.

History also falls within the same criticism. "We are a law-making people here in America," says one of our educational lecturers; "we have to learn how to make laws"! Very poor article indeed. Fewer laws, so much the better, as every law exemplifies a shortcoming; but would it not be preferable, if one wants absolutely to make laws, to begin to study, not how to make them, but what a law is? Thus with history. If once the pupil could command something like a fair, honest information and understanding of what society is, of what his own circle is, his borough, his county, his State, their institutions, etc., with some elements of civil government, then of course he could trace the various historical reasons for the present institutions, have a rational idea of his own country as a standard, and compare it with others, but then only would he be ready for history; otherwise the couple of dates and stereotyped versions about the courage of the good Putnam and the cowardice of the English, the ideality of the North and the blackness of the South, etc., will be

only an evil, and unnecessarily feed the youngster, and that at a very impressionable age, with unjust prejudices. The writer had some curious experiences in that direction, especially when, for the fun of the thing, he wanted to have Republicanism and Democracy defined and limited by Republican and Democratic voters, graduates from public schools, and, he is sorry to say, graduates from apparently known colleges also.

To sum up, more grammar and less grammatical instruction would also be desirable. Mathematics more practically taught, problems of actual use from elementary mechanics, would, for instance, be found more useful than the traditional apple cut up into $\frac{999}{1111}$ parts, and would equally well illustrate the principles intended in arithmetic.

Then, with a few dollars spent for plant and materials in industrial education with drawing, we should have our public schools doing really a great work, because actually preparing men for real life.

Following the woman emancipation question we shall probably see a number of clerks gallantly leaving their places to so many lady candidates, book-keepers, etc., and possibly shall we chauvinize ourselves sufficiently to recognize and socially respect (not politically) our new gentleman in overalls, but at large society will have gained only by that; and probably our hot question now, that of labor and capital, will have lost considerably of its disagreeable aspect. General smartness, and what we call general literary information, have had their day; they do not protect us now from a very unhygienic and unsavory fare. Now, as to the special course of manual training in higher preparatory schools. A chemical laboratory, a physical laboratory, scales, standards of measure, specific gravities, thermal, barometrical, electrical units, more minute calculations, would represent the variety necessary, covering the scientific parts more minutely, but by no means dispensing with actual shop practice and thorough work in it. Such training will be found very useful in a professional career; it will enable also the future leader of work and labor to estimate it thoroughly, to understand its difficulties and its actual value, and therefore its needs and rights. It may do away with some of our typical social *dilettanti*, but most assuredly it will create the true social type of man, struggling for his existence, and surviving because the fittest, but expecting more profit from, and directing, therefore, more energy toward, the struggle with Nature and her forces than toward a battle with his fellow-men.

SKETCH OF PAUL BERT.

IN Paul Bert we have an example of a man who was able to achieve equal eminence in scientific research and in political life; and one of those extremely rare cases in which the excellence of scientific achievement was not apparently marred by the worker's participation in political activity. Announcing his death in the Chamber of Deputies, in November, 1886, M. de Freycinet said, "The members of the Chamber lose in him an eminent colleague, science one of its most illustrious representatives, and the Government an inestimable fellow-laborer in whom it had placed entire confidence."

M. BERT was born at Auxerre, on the 17th of October, 1833. He pursued his studies in his native town and in Paris, and obtained the degree of Doctor of Medicine in 1863. His graduating thesis was upon animal grafting, and in it, M. Gaston Tissandier says, the physiologist marked himself as an eminently original investigator and skillful experimenter. Three years afterward, in 1866, he was admitted as a Doctor in Natural Science on the basis of a thesis upon the "Vitality of the Animal Tissues." His first labors attracted attention particularly by the interesting and curious nature of the results obtained. Animal grafting, an operation consisting of the removal of a living part and transplanting it so that it shall continue to live on another part of the same individual or on another individual, was studied in a special manner by the young physiologist, who was enabled thereby to shed a new light on the properties of the nerves. This was remarked by Claude Bernard, in whose laboratory he became an assistant, who discerned an ingenious mind in him, and predicted the brilliant future that awaited him. In 1865 the Academy of Sciences decreed to M. Bert the prize in Experimental Physiology. Two years later, in 1867, he was appointed to a chair in the Faculty of Sciences at Bordeaux; and in December, 1869, he was named Professor of Physiology in the Faculty of Sciences in Paris, as Bernard's successor. Here, in the possession of a vast field of study, M. Bert, with the financial aid of Dr. Jourdanet, constructed costly and magnificent apparatus for the execution of experiments on barometric pressure in relation to the effects it exerts on the organism. Dr. Jourdanet, having removed from the borders of the Gulf of Mexico to the highlands of Anahuac, had observed differences in pathological conditions, which he discovered, to his surprise, were not simply such as result from temperature or are paralleled in places of lower level and higher latitude, but presented peculiarities which he conceived to be dependent on the elevation of the situation alone. Among these conditions was

a poverty of the blood-corpuscles in oxygen, which he believed to be a result of the feeble pressure of the atmosphere in those regions. In the study of the question of the influence of atmospheric pressure on health, which he was led by these observations to undertake, he availed himself of the aid of M. Bert's experimental skill. M. Bert performed a long series of experiments upon small animals exposed to atmospheres of various pressures. The book in which he gave an account of them includes full reviews of excursions into great altitudes, of observations on mountain-sickness, and of balloon ascensions to great heights. An experimental ascension in the balloon Zenith was made in 1875 in aid of this investigation, its special object being to determine the quantity of carbonic acid contained in the atmosphere at an altitude of twenty-four thousand feet. Three persons went up in the balloon, two of whom, M. Sivel and M. Crocé Spinelli, perished at a height of about twenty-four thousand feet, from the effects of the rarefied air, while the survivor, M. Gaston Tissandier, was made insensible for a considerable length of time. The main cause of the disaster was believed to be "the vertigo of high regions," by which the aëronauts were excited to throw out ballast and go higher, when prudence should have dictated to them to descend. The main object of the expedition was not attained, because the instruments also were thrown out and broken. The balloon reached a height of eight thousand six hundred metres, as was shown by the maximum barometers. The results of Prof. Bert's experiments were published in 1878, in his work "La Pression barométrique; Recherches de Physiologie expérimentale" ("Barometric Pressure; Researches in Experimental Physiology"). Among his principal conclusions were those that the diminution of barometric pressure acts on living beings only by diminishing the tension of the air which they breathe, in the blood which animates their tissues, and by thus exposing them to the dangers of asphyxia; that the increase of atmospheric pressure acts only by increasing the tension of the oxygen in the air and the blood; that the inconvenient effects of diminution of pressure may be efficaciously combated by the respiration of an air sufficiently rich in oxygen to maintain the tension of that gas at its normal value, and those of the increase of pressure may be combated by employing air sufficiently poor in oxygen to arrive at the same result; that the beings actually existing in a wild state on the surface of the globe are accommodated to the degrees of oxygenated tension under which they live; that barometric pressure and the proportion per cent of oxygen have not always been the same on our globe—the tension of the gas has apparently been, and will without doubt continue to go on, diminishing; and that it is inaccurate to teach that plants must have appeared on the earth be-

fore animals, in order to purify the atmosphere of the great quantity of carbonic acid which it contained. In fact, germination, even that of mildew, does not take place in air sufficiently charged with carbonic acid to be fatal to warm-blooded animals. It is quite as inaccurate to explain the anteriority of reptiles to warm-blooded animals by the impurity of the air tainted with too much carbonic acid. Reptiles, in fact, are more injured by this gas than birds, and still more so than mammals.

For these experiments, the Academy of Sciences, judging them worthy of the highest recompense in its power to bestow, awarded to Prof. Bert its grand biennial prize of twenty thousand francs.

Another important research of M. Bert was concerning the safe administration of chloroform and other anæsthetics, for which he devised a special apparatus.

A considerable portion of the work of Prof. Bert was performed in the public service. After the military disasters of 1870, he became Secretary-General of the prefecture of the Yonne, and in January, 1871, prefect of the Département du Nord. He resigned this office when Gambetta retired from the Department of War. He was chosen deputy from the Yonne in 1874; took his seat among the Extreme Left; and participated actively in the discussions of the National Assembly, particularly on questions relating to ecclesiastical and educational matters, strongly opposing the pretensions of the clergy to control the education of the young, making alarming exposures of the abuses which it was alleged they had allowed to be introduced into the schools, and condemning the teachings of some of their text-books. He advocated the giving of an annual pension of twelve thousand francs to Pasteur, and was one of the deputies who, in 1877, refused to give a vote of confidence to the De Broglie ministry. From 1877 to 1879 he represented the Canton of Ailtenet in the General Council of the Yonne. His appointment, in 1881, in the Gambetta ministry, as Minister of Public Instruction and Worship, was regarded with great disfavor by the clericals, who looked upon him as their pronounced enemy. His administration of the office was able, and furthered the movement to secularize the schools. The bill passed by the Chamber in March, 1884, was his work, and was a stringent measure for the accomplishment of that purpose. It directed the Government to secularize the state schools entirely within five years, by appointing lay teachers instead of the friars and nuns, who had a large proportion of the schools under their control; debarred the clergy and members of religious orders from the direction of primary schools as teachers, inspectors, or members of the educational councils, or of the officially appointed school boards; and forbade lay instructors from accepting salaried employments in the churches.

M. Bert was appointed in January, 1886, French Governor-General of Tonquin, and Minister-General to the court of Anam, where his functions were to be largely those of organization. He engaged himself with the duties of this mission with characteristic enthusiasm, applying himself almost equally to the performance of the civil work of his position, and to efforts for the encouragement of science in the new French dependency in which he was stationed. One of the last occasions on which he appeared in public in France was at the unveiling of the statue erected at the entrance of the Collége de France to the memory of Claude Bernard, where he delivered one of the addresses. At the ensuing meeting of the Academy of Sciences he made a farewell address, in anticipation of his departure, in which he expressed a hope that the young naturalists of the West would begin to turn their attention to the far East, and teach the learned classes of those regions more fully to appreciate the superiority of European science. "I rely on them," he added, "to increase our moral influence, and also to enlarge our knowledge of that region, in many places still unexplored, to study its resources, and prepare the way for the introduction of the great European industries. They will thus at once promote the interests of science and of France, a task enviable beyond all others."

Shortly after he had settled himself in his office in Tonquin, M. Bert published a decree to carry out a project, which he had entertained and matured before leaving France, for founding a Tonquinese Academy, on a plan similar to that on which Napoleon created the Egyptian Institute in 1798. It was set forth, in the preamble to this paper, that it was desirable to revive in the country which had been disturbed for so long a time the taste for literature and science, and to preserve to the people the vestiges of its glorious past, as well as to collect the scattered evidences of its ancient splendor. It was provided that the seat of the academy should be at Hanoi; and that its functions should be to investigate and collect everything of interest relating to Tonquin, to preserve ancient monuments, to initiate the people into the knowledge of modern sciences and civilization by translating and publishing in the Anamite language summaries of European works; to translate desirable Tonquinese works into French; to aid in forming a national library at Hanoi and public libraries in the principal towns; to publish monthly bulletins treating of scientific and other questions; and to put itself in relation with other Oriental societies in Europe and Asia. Various degrees would be given by the academy to Tonquinese, to be marked by a medal or emblem to be worn on the dress.

One of the last letters written by M. Bert from Hanoi was in reference to the improved lighting of the city at night. Gas being

too dear, and the use of petroleum being a "barbarous expedient," he was anxious to know whether it would not be possible for him to make the Red River, which flows past the capital, produce the required illumination. "Would the expense be great?" he asked. "Only think, if we succeeded, we should be ahead of England and Japan! . . . Answer, and answer quickly; my days are numbered." This letter was deposited, by vote, in the archives of the Academy of Sciences at Paris.

During the first months, of his stay in Tonquin, M. Bert enjoyed the best of health. But the constant friction which existed between himself and the military authorities worried him, and the climate of Hanoi wore upon him. He concealed, as much as possible, the fact that he was becoming ill, and was anxious that none but good reports should go out concerning the country. When called to go to Anam in September, it was remarked on board the steamer that "he was ever full of that good humor which he had the gift of communicating to others. He was always surrounded by a little circle of friends, who left him the stronger and the better advised. At table his marvelous appetite contrasted curiously with the dejected features and languishing airs of his traveling companions, and it seemed as yet impossible to believe in his unforeseen, sudden death." "It is difficult," says the author of a letter in the "République Française," describing a "Last Interview" with him at this time, "to form any idea of the indefatigable activity which M. Bert had displayed ever since his departure from France. At Hanoi he was shut up in his room early in the morning till his family came to call him to breakfast. In the middle of the hot day, at the hour which even the most robust dedicate to rest and quiet, he was found at his work, which only ended at five, with the end of the day. At five—his family were waiting patiently for him; they were all going to drive out together, but the time passes, and M. Bert does not appear. He is looked for everywhere, and at last he comes, only to tell his friends that an officer is dying at the hospital, or that one of his functionaries is ill, and that he must go and see them both. At the Hanoi hospital, whence the French soldiers and travelers are buried who have died in the neighborhood, M. Bert followed each coffin to its last resting-place. Times without number he has walked through this hospital, distributing books and medicines, and bringing such consolation which only those can fully appreciate who have been ill away from their own country and their own people."

Two weeks before his death he telegraphed confidentially to M. de Freycinet that he was ill, and it would be well to appoint his successor. M. de Freycinet replied that it would be better for him to rest, and that his retirement would be detrimental to the public interests; and he responded: "You are right; better die at

my post than quit Tonquin just now." He had gone for rest to the Doson Peninsula, a favorite resort of Europeans in Tonquin for recreation, where he had built him a small house in which "he intended to rest when he should be tired." He suffered a fresh attack of dysentery, from which he died in five days, on the 11th of November, 1886. On the announcement of his death in the Academy of Sciences, addresses were made by President Jurien de la Gravière and M. Vulpian, in which references were made on the great services which he had rendered to science—especially in his researches on the action of light on living organisms; on the physiology of respiration; on the influence exercised on man, animals, plants, and ferments, by increased or diminished pressure of atmospheric air, of carbonic acid, and of oxygen; and on his theory of the physiology of anæsthetics, and his efforts to render absolutely inoffensive the inhalation of protoxide of nitrogen. M. Bert, M. Vulpian added, was endowed with one of the most open minds to be found, and his prodigious facility in work permitted him to bring many tasks to the front. Most of his researches were undertaken and carried to a good result while he seemed to be wholly given up to labors of another kind. What might we not yet have expected from his indefatigable energy?

M. Bert was endowed with an extraordinary capacity for work. Although in his latter days political life seemed to absorb his attention, he found time to receive numerous visitors, to prepare standard works, to write scientific articles, and to keep up a voluminous correspondence. While he was regarded by the general public as harsh and authoritative, he was in private life a man of charming simplicity and a most agreeable conversationalist. His Wednesday evening receptions in his apartments in Paris were most agreeable occasions to all who were privileged to participate in them, and were marked by a free flow of conversation in which the host was among the most lively talkers, and science always held a prominent position. He had, says M. Gaston Tissandier, an absolute faith in himself, and did not believe that his star could be dimmed. He departed for Tonquin with the feeling that he had a great duty to perform, and was glad to believe that the difficulties in the way of his mission would yield before his determination to triumph over them.

Besides the volume on "Barometric Pressure," already referred to, M. Bert's chief publications were "Revue des Travaux d'Anatomie et de Physiologie publié en France pendant l'Année 1864" (Review of the Works on Anatomy and Physiology published in France during the Year 1864), 1866; "Notes d'Anatomie et Physiologie comparées" (Notes on Comparative Anatomy and Physiology), second series, 1867–'70; "Recherches sur la Mouvement de

la Sensitive" (Researches on the Movement of the Sensitive-Plant); "Leçons sur la Physiologie comparée de la Respiration" (Lessons on the Comparative Physiology of Respiration), 1869; "Recherches expérimentales sur l'Influence que les Modifications exercent sur les Phénomènes de la Vie" (Experimental Researches on the Influence which Modifications exercise on the Phenomena of Life), 1874; "La Science expérimentale" (Experimental Science), 1878; "La Morale des Jésuites" (The Morals of the Jesuits), 1880; "Leçons, Discours et Conferences" (Lessons, Talks, and Lectures), 1880; "Leçons de Zoölogie professées à la Sorbonne" (Lessons in Zoölogy taught at the Sorbonne), 1881; "La première Année d'Enseignement scientifique: Sciences naturelles et physiques" (The First Year of Scientific Knowledge: Natural and Physical Sciences), 1882; "L'Instruction civique à l'École" (Civic Instruction at School), 1882; and "Discours parliamentaires" (Parliamentary Addresses), 1882. For many years he furnished a scientific *feuilleton* to M. Gambetta's journal, "La République Française." The "First Year of Scientific Knowledge" has been translated into English, and is published by D. Appleton & Co. It is intended for children beginning to study science, and has probably no superior in suitableness for that purpose. It has proved an extraordinarily popular book in France, where it is said to have made the author's name known to a vast number of persons who knew nothing of his eminence either in science or in politics.

Professor Archibald Geikie names four obvious sources of information regarding former conditions of the land: the testimony of historical documents; the names of places; tradition; and geological evidence. The historical testimony is not always direct, but is often very strong by incidental reference; and of this character are the allusions in poems and romances. Numerous local names which have now lost significance or seem inappropriate, are found upon analysis to have been descriptive, at the time, of the places on which they were conferred. So tradition, when well sifted, often throws light upon mooted points. Geological evidence is the best, the most accurate, the most lasting, and goes farthest back.

Some excellent maxims are given in a book on "The Ministry of Fine Art to the Happiness of Life," by Mr. Gambier Parry. On "The Purpose and Practice of Fine Art," the author says that "fine art comes of the union of love and labor, for without love it has no sufficient motive, and without labor it can have no success." The first step in a student's life, he adds, "is to divest his mind of all idea that genius can dispense with labor." A glaring fault of much of the work of the day is rebuked in the precept, "Of all the vices which pollute the source and thwart the progress of fine art, the striving after novelty is among the worst." Impatience and fickleness of purpose are condemned in "the genius most precious to mankind is continuous."

CORRESPONDENCE.

INDUSTRIAL ADJUSTMENTS.

Editor Popular Science Monthly:

I BELIEVE it will be the verdict of the readers of Hon. David A. Wells's papers recently concluded in the "Monthly" that they have given the most luminous sketch of the complex courses of modern industrial life that has yet appeared. Probably no writer has fortified his ideas by such a broad acquaintance with the living facts of industry; none has reached his conclusions by so wide an induction. And the absence of partisanship in ideas, the "philosophic calm" attained by so few even among philosophers, have been shown by Mr. Wells in a remarkable degree.

Instead of vague and incoherent talk about stock-watering, the Standard Oil Company, Jay Gould, speculation, and other all-sufficient "causes," we have had clear statements of the actual facts observed in the various departments of trade. Mr. Wells has shown us how one change in business led to others, and how these others disturbed still others; how nearly every walk of life has been greatly changed by the introduction of new processes, dependent, primarily, upon the application of steam and electricity to industry. From this review we see how little individuals have controlled the course of events, and how inevitable has been the revolution through which we have passed; and how Legislatures and States have been little more potent than individuals. In fine (if I may venture to state comprehensively the net result of Mr. Wells's papers), we have been shown that—

The industrial disturbances lately felt throughout civilization have consisted in the economic waste, the displacement of occupations, capital, skill, and social habit, due to the rapid and unceasing change in the methods of production and distribution; which change was itself due principally to the great mechanical inventions; that, among business classes, panics have been the result of the continual overthrow of established forms of business by new forms, and the unequal and disorderly rush of capital into these new forms, alternating oversupply with scarcity; and that among the laboring-classes there have been a corresponding displacement, insecurity, and suffering.

That part of Mr. Wells's essay which deals with the remarkable increase of social discontent attributed to our time seems to me the least satisfactory part of his performance. The result of his observations on this point seems to be that there is no valid reason for this discontent, and that the "laboring" and all other classes are better off than ever before. He indeed shows that much suffering has arisen from the "displacement of labor through more economical methods of production and distribution"; as where the hand-loom weavers were thrown out of employment by the introduction of the power-loom. But he also shows that these displacements have been only temporary, that the demand for labor soon becomes all the greater because of the new methods, which must lead us to infer the insufficiency of the cause assigned to account for the phenomenon, especially as sudden displacements have taken place only in a small proportion of industries. Two other causes are assigned: changes in the nature of employments, which tend to degrade the operatives of factories, and a general increase of intelligence. But no very serious effort seems to be made to support these hypothetical causes. Indeed, they may perhaps be said to exclude each other. Man is certainly a very unfortunate creature if he grows unhappy both when circumstances lower his "grade" and lessen his intelligence, and also when his intelligence is increased. For such a state of things there would seem to be small hope of remedy, since we can scarcely hope to maintain a dead level. The reader is left somewhat in the dark on the matter.

Content and discontent are doubtless largely dependent upon the quantity and quality of the food we have, the money we lay by, and the houses we live in; upon all of which Mr. Wells throws so much light. But it is superfluous to argue that happiness is dependent on conditions much more complex than these. The greater part—I think by far the greater part—of the unhappiness in the world comes from other things than insufficient food, clothing, and shelter. "All happiness in life," says Goethe, "is founded upon the regular return of external things." This remark of the great philosopher and poet, for which the equivalent could doubtless be found in Spencer's writings, seems to me to furnish the key to the problem. Our race has been accustomed for numberless generations to harder work and infinitely greater risk and privation than it endures at present; but it also had a character inured through hundreds of years to its occupations and had habits and desires approximately conforming to its necessities. But the violent transition through which we have lately passed has probably changed to a very large extent the occupations of ninety-five per cent of the population within a single generation. The old, happy-go-lucky, sit-around-and-whittle-a-stick generation has been ruthlessly exterminated. Even the good old philosophy

of Franklin's "Poor Richard" has had to go; and, in place of the steady, conservative habits which Franklin inculcated, we have a fierce philosophy which perhaps best expresses itself in the current determination not to "get left," and to get there "fairly and easily if possible, but at any rate to 'get there.'" The industrial world has been revolutionized in a half-century; and the non-adaptation of the population to its industrial environment has put a severe nervous strain upon the entire race. Hence comes the great and annually increasing percentage of insane to be found in all civilized countries, and particularly in the United States and England. Our condition has been materially bettered, but this does not altogether compensate for the strangeness of the surroundings; and, like the child of the forest brought unwillingly into civilization, mental health longs for a little barbarism. Naturally, under the circumstances, the most striking of the ill effects of the strain imposed by the new conditions are found in the foreign population which comes to this country with so little preparation. The proportion of insane among this class is very great. But the force of the resisting and reactive tendency may be seen almost everywhere. A college president recently called in a state church as a remedy for our woes, a medicine in order some ten centuries ago. Among economists we have a "new" school, composed largely of young men of little practical experience, who have got their ideas in German universities, and who exhibit a profound partiality for despotic government, and the revival of that *régime* where "the state" was everywhere. In letters we have Carlyle, whose passion for the imperialistic, the feudal, the patriarchal, joins with his contempt for liberalism of every form; Ruskin, whose detestation of the steam-engine and modern arrangements in general reaches an insane pitch; and Tennyson, the central note of whose thoughtful poetry is one of unrest and impatience. These great writers faithfully reflect the feeling of many, and perhaps most of us; and similar tones are found in our lesser writers. It is rather ludicrous to note how often the newspapers call for "rigid" legislation of some kind or other. And of course the Legislatures and courts have not failed to reflect faithfully, as is their duty, the temper of society at large. Thus, along with our great advance, we are suffering the agitation and disquiet of a necessary reaction. Travelers on the St. Lawrence will remember a scene typifying our social situation. As the steamer falls into the swift current of the Lachine Rapids, and takes on a fearful speed, we notice short, steep waves angrily assailing us from front and sides. These waves are raised by the rapidity of the water's descent, which, rushing downward at a rate of twenty-five miles an hour, is lashed to fury by the air, just as a rushing air raises the still waters of a lake or ocean. And the very swiftness of the descent is indicated by, and makes inevitable, the violence of the resisting waves, as we shoot down to the calm waters below the rapids.

A republication of Mr. Wells's articles is very desirable. It seems to me that they will be accepted as the best contribution of recent years to economic science. Pardon my long letter. CHARLES S. ASHLEY.

TOLEDO, *May* 5, 1888.

FOG-SIGNALS.

Editor Popular Science Monthly:

SIR: Mr. A. B. Johnson, in his article in the May number, on "Sound-Signals," referring to my code, commends it as the best he has yet met with, but alludes to it especially as an adaptation of the Morse code. To correct any impression that might arise that my code was *suggested* by Morse's telegraphic alphabet, I beg to state that it simply has nothing to do with the Morse code, except that the different signals, long and short, with varying intervals of silence—or non-signaling—may be indicated by dot and dash on a compass-card or chart for convenience. The signals consist of whistle-blasts, indicating, not only the position of a vessel in fog or darkness, but also the direction in which she is moving. It is not designed as an alphabet, except to indicate *courses* being steered by vessels in danger of colliding if they did not indicate in some way as approximately as possible *their position and course.*

Without disputing the facts already stated in this magazine, and in previous articles by the same writer, founded on scientific observation — viz., that aberration of sound does occur from various causes, and that exact location of an object by sound may be impossible—still, it has been the ambition of the writer of this to establish the use of a code of fog-signals at sea designed to prevent collisions by indicating the course a vessel may be steering. At present, signals by sound between vessels in motion, indicating course, are given when they are each *in sight*, or at least when one discovers the proximity of the other. By the present code of signals they may indicate whether they will pass to the right or left of each other, and this is done by blowing one or two whistles to which the response is supposed to be favorable from the vessel signaled.

This code of signals may be good enough for every purpose when vessels are *in sight*, but gives at best *very slight warning* when vessels are approaching each other in fog or "thick weather." Something more is demanded as a warning of approach, and the more intelligible and informing this warning signal can be the better. It has been advocated that a signal indicating a vessel's course as being in either of the four quadrants of the compass—as between N. and E., E. and

S., S. and W., W. and N.—or between N. W. and N. E., N. E. and S. E., S. E. and S. W., S. W. and N. W.—be indicated by 1, 2, 3, or 4 whistles, corresponding to the number of the quadrant. In every case the whistles to be short, but preceded by one long one.

A suggestion has also been made that a "tattoo" or multiple whistle be given to indicate "I have stopped—you may go ahead." Some such system as this might be comparatively useful; the only question to settle in this regard is, What is *the best* system devisable? In endeavoring to answer this question I have made use of the long and short signal, which can be, incidentally, represented on a compass-card or otherwise by the dash and dot. These signals, given at intervals suitable to prevent confusion, will indicate *any* course on the compass, and can be read by sound as soon as they are in process of transmission. Opposite courses are indicated by opposite signals. N. and E. courses by one — and two — — long signals; S. and W., by one . and two . . short signals. Thus, as soon as the signal starts off, the navigator learns at once *something* of the *direction*, in a general way, soon to be particularized, in which a signaling vessel is moving, being thus enabled to avoid getting in the line of that motion, and so preventing collision. Actual experience tells us that navigators *do locate* approximately the position of ships by sound—of course with more accuracy by sight. When sight is unavailable, we *must* depend on sound. Yours truly,

FRANK M. PURINTON.

PROVIDENCE, R. I., *May* 1, 1888.

EQUALITY OR PROTECTION.

Editor Popular Science Monthly:

DURING the recent Parliament at Washington, one point seems to have been clearly developed—viz., that women are no nearer the ballot-box than they were fifty years ago—and this despite the efforts of an earnest and loyal minority. The truth is, that the masses of American women do not care to vote, and this wide-spread, persistent indifference leads us to hope that, at no very distant date, the restless ghost of woman-suffrage will at last be laid, to rise no more.

The word "equality" promises to be the next stumbling-block in the way of woman's real progress, and we can not but believe that the ladies who are acting in behalf of their sex are decidedly hasty and incautious in demanding, without limitations, "equal pay for equal work." At first sight, indeed, the proposal seems a fair one; and in art, literature, and latterly to a great extent in science, the equality of the sexes is unquestioned. But in the rough, every-day work of the world, where weakness means failure, strength success, where sentiment counts for nothing, and money-making is the paramount object, the matter is a very different one. That a woman can acquire the routine of almost any mercantile pursuit, may be admitted beyond a doubt; in fact, the quickness of her mind, and her rapid if superficial grasp of a subject, will give her the advantage, in many branches, over her brother-workers. Despite the utmost reserve and discretion, however, a woman is an anomaly in a business office, among business men, in the unrelenting tide of business life. She may do her work as well as a man would, be as reliable, as faithful; but her presence is an inconvenience, a possible restraint, only to be counterbalanced by the cheapness of her labor. No man, who is worthy of the name, can quite bring himself to treat a woman clerk as he would a man, even in this ungallant age; but in this business warfare the small courtesies of life are necessarily neglected, and an employer who has expressed his disapprobation or impatience without much regard to his p's and q's, may be dismayed on finding that he has insulted a female; for the slow masculine mind does not yet understand that women mean to prefer equality to respect and consideration.

Then, what might be called the transitory nature of woman's work must be taken into consideration. It can not be taken for granted that every woman who has to make her living will be old, ugly, and uninteresting; therefore, marriage must be considered as a possible if not a probable interruption to her business career. Unless domestic life is to cease altogether, she retires from outdoor vocations to fulfill her household duties. A man, on the contrary, will feel it the more necessary to keep his position, and advance himself in his business. In the face of such contingencies, can an employer be expected to pay equal wages?

In conclusion, is it not too soon for women to *demand* anything of the other sex? Equality means competition; competition means a fierce and ungenerous battle, from which many a strong man emerges sorely wounded and unvictorious. Are women fitted to enter into such a contest as yet? Will it not be a long while before their nerves will be strong enough, their muscles hard enough, their feelings insensitive enough, to make the fight a fair one? Is not Nature, potent and inexorable, behind the artificialities of civilization, the *real* bar to feminine equality after all?

In the mean time, it would be more prudent in women, even those termed strong-minded, not to scorn the protection of those of the other sex who are willing to protect them merely *because* they are women. And in their efforts for self-advancement and independence, let them rather *ask* aid, sympathy, and encouragement from their masculine fellow-workers, than demand an equality which the world is not willing to grant them, nor are they yet ready to receive.

MRS. L. D. MORGAN.

315 WEST MONUMENT STREET,
BALTIMORE, MD., *May*, 1888.

EDITOR'S TABLE.

THE STATE AND SOCIAL ORGANIZATION.

IT would probably be hard to find an expression around which so many false and confused ideas have gathered as we find clustering around the term "the state." In the course of an otherwise excellent article which we read lately in one of our educational contemporaries, we find "the state" described as being "simply society organized." Now, we can only understand by this that, apart from political government, there is no social organization; yet surely nothing could be wider of the truth. The fact is, that true social organization is seen at its best precisely where the state is not—that is to say, in those regions of social activity with which political government does not interfere. Think of our churches, our charities, our clubs and institutes of one kind and another, our commercial system with its constant tendency to higher and more complete organization, the newspaper press, the railway and telegraph systems, our multitudinous social arrangements, and the thousand and one purely voluntary agencies by which human intercourse is facilitated and improved; and at once it becomes obvious how misleading it is to speak of "the state" as being "society organized." It would be nearer the mark, in our opinion, to say that true social organization begins just where state action ends. The essential function of the central power is to preserve the integrity of the community by shielding it from external attack and internal disruption, and so to provide the conditions for social organization. In other words, the state maintains order as the condition of progress; but progress, if it is to be worth anything, must result from the innate powers and affinities of the units composing the social mass.

It should never be forgotten that the state, as such, proceeds by coercion. It does not ask for taxes; it demands and takes them. It does not use moral suasion on recalcitrants, but applies at once the *ultima ratio* of baton and handcuffs. If the state, for example, makes itself the champion of temperance reform, its language is: Do this, refrain from that, or—go to jail. But social organization, in the true sense, is not a matter of compulsion, and can not proceed from compulsion; it is a matter of growth; it means the sorting out and aggregation of like social elements, and the weaving by the whole body of society of such forms, usages, customs, principles, and institutions as are most in harmony with its character and conditions. What is effected by legislation simply can be overturned by legislation just as easily; but what is accomplished by a spontaneous growth of sentiment is really wrought into the very structure and fiber of society. There exists the gravest doubt to-day whether the state of Maine has gained anything whatever by its legislative prohibition of the liquor-traffic; many, indeed, hold that the cause of temperance itself has suffered through the measures adopted to promote it, and that the whole moral tone of the community has been lowered by the unceasing spectacle of the conflict between the prescriptions of State authority and the claims of individual liberty. Our form of government tends greatly to disguise the truth that social organization is a product of freedom. If a monarch or other autocrat were to enact certain laws that find favor in different parts of this country, there would be an outcry against his tyranny, and he would certainly be suspected of many a sinister motive. But, because these laws express the will of the majority, they pass

without challenge; the prior question is not raised whether the case is one in which the majority should seek to impose by force its will on the minority. The question is not asked whether society, if left free to act according to its own laws, would not in due time—which is always better than *undue* time—accomplish the good that is aimed at, and with better ultimate results than when force is invoked to hasten the reform.

The specific danger of our time is the easy access which mere majorities have to the law-making power, with the consequent passion our several communities have acquired for what may be called the law-making habit—a habit entirely comparable with the drink-habit or the opium-habit. We stimulate or soothe ourselves with laws, as the case may be, instead of striving to bring about the end we desire by free co-operation. We legislate (in the most futile manner) against oleomargarine, we legislate against "bucket-shops," we legislate against railway discriminations, we legislate, or threaten legislation, against "combines" and "trusts"; and, having legislated, we legislate again and again to make up the deficiencies or remove the contradictions of former legislation. Meantime the growth of free opinion and sentiment on the subject-matter of all this law-mongering is not aided but retarded. One result of this vicious habit is, that we do not give ourselves time to properly understand the workings of this or that tendency before we rush to legislation in order to forward or hinder it, according to the opinion we have been led to think it hurtful or beneficial. And how easily in many of these matters public opinion is swayed by mere catch-words no judicious student of public affairs can help being aware. As regards the treatment of our bodily ills, we have—at least intelligent people have—got to the point of distrusting the quacks who undertake to drive away every specific ailment by an equally specific nostrum; and we give our confidence rather to those who study the general conditions on which health depends, and who place their own chief reliance on the curative force of Nature. In statecraft, however, we hear nothing, broadly speaking, of general principles, nothing of the tendency of things to right themselves if left alone, nothing of the organic and organizing forces of society, but everything of the dependence of social well-being upon specific measures of legislation. Politically, we are yet in the dark ages. It is true we have thrown off the power of the personal tyrant, but we have not entered into the freedom of those who look to Nature for their guidance, and who resent the yoke of all arbitrary laws, no matter by whom enacted. The time will come when the art of government, like the art of healing with which it has many points of analogy, will be put upon a natural basis, and then it will be seen more clearly than now how little government has to do with social organization beyond providing for it the necessary conditions of order and stability.

A PHILISTINE CHAMPION.

A CERTAIN record tells us that when the Philistine army was drawn up in front of that of Israel, a champion of great size, arrayed in portentous armor and carrying a sword and spear of enormous proportions, came forth from the Philistine ranks and challenged the Hebrews to send a man to fight with him. We read also that when David, the son of Jesse, stepped forth to the encounter, armed with a few pebbles, the huge Philistine "cursed him by his gods." Now, somehow or other, the Lord of Argyll and the Isles, who has lately stood forth, from another "Philistine" camp, to challenge the hosts of science, and, if not to curse, to indulge at least in some good Homeric *loidoria*, reminds us powerfully of that Goliath of Gath who had so vast a contempt

for David and his pebbles, but whose strutting and boasting one of those pebbles brought to a sudden end. The duke is not a man of huge physical stature—quite the reverse people say who have seen him; but he is armed in a panoply of multifarious knowledge, he is practiced in the use of controversial weapons, and he has the truculent tone befitting one who constitutes himself the champion of reactionary ideas, and who hopes to make bluster do to a large extent the work of argument. After assailing Prof. Huxley, and with him nearly the whole body of modern men of science, in the geological field at least, on the absurd ground that they had conspired to smother a certain new theory of the origin of coral-reefs, simply because it differed from the one promulgated by Darwin, he turns his attention to Mr. Herbert Spencer, whom he represents as having made, in his "Factors of Organic Evolution," a "great confession" as to the inadequacy of the Darwinian view of the origin of species, and whom he further charges with a persistent effort to degrade philosophy to the lowest possible level. Upon both points the Philistine champion is simply as unjust to Mr. Spencer as it is possible for him to be, and this we propose to briefly show. We invite our readers, however, to turn to the pages of "The Popular Science Monthly" for verification of what we have here to say; for at different times we have published all the more important parts of the controversies now in question, including the Duke of Argyll's article, "A Great Confession," in our number for May, and Mr. Spencer's "Counter Criticism" in that for June.

To make "a great confession" must mean—if it means anything—to acknowledge some serious error on one's own part. To assert the deficiencies of another man's theories is not to make a great confession or any confession. Now, Mr. Spencer's work on "The Factors of Organic Evolution," far from being a confession of error on his own part, was an attempt to fix attention upon a view of his own which he holds now, as he has done for many years, to be of much importance as a complement to the Darwinian doctrine of the origin of species. If some one who had strongly asserted the all-sufficiency of the principle of natural selection, independently of the action of the principle contended for by Mr. Spencer, that, namely, of the inheritance of functionally produced modifications of structure, had come round to Mr. Spencer's view and published a treatise similar in scope and object to his on "The Factors of Organic Evolution," *that* might have been called a confession. Whether it would have been a "great" one or not would have depended on the writer's rank in the world of thought and the extent to which his previous views had affected scientific opinion generally. In Mr. Spencer's case there was no "confession" at all: on the contrary, there was the reaffirmation of a special view of his own, and a re-enforcement of it by additional arguments.

Had our Scotch Goliath admitted the force of Mr. Spencer's arguments, in so far as they tend to show the insufficiency of the principle of natural selection, pure and simple, to account for the origin of species, it might have been possible to explain his calling Mr. Spencer's recent work "a great confession" by assuming that, in his polemical haste and fury, he saw nothing in "The Factors of Organic Evolution" save a criticism—and a powerful one—on the doctrine of natural selection by the most distinguished of contemporary evolutionists. But, far from this being the case, the champion will not admit that there is any force in Mr. Spencer's arguments, but likens them to "some bit of Bumbledom setting up for Home Rule, some parochial vestry claiming independence of a universal empire." Where, then, does he find the "great confession"? How can arguments to which all force

is denied be twisted into a "confession" damaging to any scientific doctrine whatsoever?

The only "confession" Mr. Spencer makes is one which he would have made at any time during the last twenty years, and that is to the effect that his phrase, "the survival of the fittest," is susceptible of being understood in a wrong sense, if not to the same extent, at least in the same general way, as Mr. Darwin's phrase, "natural selection." This confession, however, his Grace of Argyll does not gloat over. It is at this point that he accuses Mr. Spencer of trying to rob philosophy of all dignifying elements. Mr. Spencer feels that to use language asserting or implying conscious purpose or direction when there is no evidence of anything of the kind beyond the vaguest analogy, is undesirable, and, if needlessly done, wrong. His Grace holds, on the contrary, that any suggestion of design which we discover in Nature should be treasured up and made the most of for purposes of edification. "There are," he says, "as it were, a thousand retinæ (in our brains), each set to receive its own special impressions from the external world. They are all needed, but they are not all of equal dignity. Some catch the lesser and others catch the higher lights of Nature; some reflect mere numerical order or mechanical arrangement, while others are occupied with the causes and the reasons or purposes of these." This is all very nice, but a cautious person will remember that when we ascend to "causes and purposes and reasons" we do so by virtue of a faculty totally different from mere perception—a faculty of the highest possible value when its operations can be checked and its conclusions verified, but of very doubtful value when it expatiates in regions where check and verification are impossible. A hypothetical retina or facet in the brain might conceivably reflect facts or phenomena of an external order; but how another similar mirror in that organ could "reflect" a subjective explanation of the same facts we fail to understand. We fear there is no retina or facet in our brain that can help us in this particular difficulty. The theory of design in Nature, the duke tells us, is "a higher intellectual perception." From our point of view it is not a perception of any kind; it is a synthetical judgment, as fully liable to error as any other synthetical judgment, and one that labors under the special disability of being incapable of verification.

The fact is, that it is not Mr. Spencer who degrades philosophy; it is those who seek to impose their own petty conceptions upon a universe that must ever transcend human thought. Mr. Spencer does not pretend to be able to think the thoughts of God. Men have pretended and claimed to do this in past times—to know the why and wherefore of the Divine actions both in Nature and in human history. But Mr. Spencer has advanced far enough to see that to represent the ultimate power in Nature as having acted thus and thus because, to our apprehension, such a mode of action might plausibly explain the facts, is at once foolish and irreverent. The Duke of Argyll professes to know that a certain uncouth animal living in Madagascar was fitted by the Deity with ears, teeth, a probe-like finger, and a peculiar claw, all for the purpose of enabling it to feed on the larvæ concealed in certain trees. Mr. Spencer only professes to know that an animal of this form does live on larvæ, but he does not say that he has discovered in the construction and habits of the creature a revelation of Divine purpose. He refrains from such a judgment, both from a sense of the inadequacy of human faculties for discovering purposes higher than human, and because he knows by actual experience that an appearance of order and purpose is often the necessary result of purely mechanical causes. Witness, as Mr. Spencer says, the arrangement of the pebbles on Chesil beach. Mr. Spencer

is as ready as any one to recognize purpose where purpose can, without undue presumption, be traced, but he does not see how this can be done outside the sphere of human action. The very conception of purpose he finds too small, and, so to speak, too provisional, too relative to our evanescent thought, to apply to the interpretation of Nature as a whole. The Duke of Argyll, by the extremely harsh and overweening tone of his several recent articles, has judged himself. If he could only be made aware of it, "a great confession" is due from him—a confession of the injustice done by him to the men of science in connection with their reception of Mr. Murray's theory of coral reefs, and the further and special injustice done to Mr. Spencer in representing his latest contribution to the theory of evolution in an altogether false light.

LITERARY NOTICES.

INTERNATIONAL LAW. By LEONE LEVI. New York: D. Appleton & Co. ("International Scientific Series," No. LX.) Pp. 346. Price, $1.50.

THE author's purpose in undertaking this work was to reduce to a code the leading principles of the law of nations, in order, by the diffusion of knowledge and by furnishing a collection of well-established rules on the subject, to prevent disputes and facilitate a resort to international arbitration. Attempts at codification had been made by David Dudley Field and Bluntschli, but their works did not include the positive portion of the law—that resulting from treaties and conventions. Copious summaries of these documents, so far as they bear on the subject of the work, are given in the book. Prof. Levi, who died on the 7th of May last, was eminently fitted for this work. A student of commercial law and of economical statistics all his life, and professor of the former subject in King's College, London, he was regarded as the foremost authority in the world in the statistics of commerce, so that in preparing this manual he was working in a field which he had long cultivated assiduously and with eminent success. The work consists of two parts. The first part concerns the general subject of international law, and includes a chapter on its nature and authority, a review of the progress of international relations from ancient times to the present, with epoch-marks at the Peace of Westphalia, 1648, and the Congress of Vienna, 1815; and a survey of the political condition and present international relations of the chief states of the world, each in its order. The second part contains "Materials for a Code of International Law," with chapters on the "Constitution and Sovereignty of the State"; "Frontiers"; "The State and its Subjects"; "Rights and Duties of the State"; "Equality of States"; "The Sea and Ships"; "International Intercourse"; and "Treaties." The last title is followed by summaries of the treaty-clauses concerning the various subjects of public and private interest coming within the purview of international law, each under its separate heading. These summaries are followed by discussions of "Private International Law," "Means for the Prevention of War," "War and its Effects," and "Neutrality." In the appendix are given the declarations of the powers and regulations on the abolition of the slave-trade, the free navigation of rivers, rank between diplomatic agents, maritime law, and the Treaty of Washington.

MODERN THEORIES OF CHEMISTRY. By Dr. LOTHAR MEYER. Translated from the fifth German edition, by P. PHILLIPS BEDSON, D. Sc., and W. CARLETON WILLIAMS, B. Sc. London and New York: Longmans, Green & Co. Pp. 587. Price, $5.50.

MESSRS. Bedson and Williams have done a good service for English-speaking chemists in making this valuable work more accessible than it was in the German edition. Meyer's "Modern Theories of Chemistry" has undergone considerable modifications, due to the changing aspect of the science since the first edition was published in 1864. As the book now stands, it is an account of the latest developments of the hypotheses upon which chemical work is being carried on. In the last two editions the author has, "by the introduction of the more important empirical data, sought to make the theoretical conclusions arrived at by their aid easier to

follow, and the causes leading to their foundation clearer." The first of the three divisons of the treatise deals with the characteristics of the chemical atoms. The author begins by stating briefly the necessity for holding the atomic theory, and for a knowledge of the atomic weights, and proceeds to discuss the determination of these weights from vapor-densities, from the specific heat of solids, and by means of isomorphism. He then takes up the relations between the properties of elements and their atomic weights, which have led to the grouping known as Mendelejeff's classification. The second part of the work is devoted to the statistics of the atoms, and in this division are discussed forms of combination of the atoms, the law of atomic linking, and valency. In the third division is treated the dynamics of the atoms, or the doctrine of chemical change. Separate chapters of this section are devoted to chemical change produced by mechanical disturbance and by the action of light, to heat and electricity as causes and as effects of chemical change, to the influence of mass in chemical action, and to the stability of chemical compounds. The author considers that the influence of mass has been too little regarded by chemists, but that its importance is being more and more recognized. He expects great progress soon to be made in the direction of chemical mechanics, pointed out by Berthollet at the beginning of this century. Throughout the volume he shows much solicitude that theories shall be recognized as valuable aids to chemical research, but shall not be formed too hastily, nor trusted too implicitly.

FORMS OF ANIMAL LIFE. By GEORGE ROLLESTON, D. M., F. R. S. Second edition, revised and enlarged by W. HATCHETT JACKSON, M. A. New York: Macmillan & Co. Pp. 32+937. Price, $9.

THIS comprehensive treatise is described on the title-page as a manual of comparative anatomy, with descriptions of selected types; and the distinctive character of the book, as the late Prof. Rolleston wrote in his preface to the first edition, seventeen years ago, "consists in its attempting so to combine the concrete facts of zoötomy with the outlines of systematic classification as to enable the student to put them for himself into their natural relations of foundation and superstructure." The present edition of the work was begun by the author in 1879, the rewriting of several portions being intrusted to Prof. Jackson, whom Prof. Rolleston further requested to complete the revision in case he was prevented from doing it himself, and this his death made necessary. The book consists of three sections, the first consisting of descriptions of prepared types, which include the rat and rabbit as types of mammals, the pigeon, ringed snake, frog, perch, and a representative of each of fourteen other classes. The second section comprises descriptions of fourteen plates, four of which are taken from the specimens described in the first part of the work, five others are from specimens of the same animals as described in the first part, but prepared differently, and there are five plates which relate to animals or groups not described before. The remaining two thirds of the volume is devoted to a general account of the animal kingdom, which has a brief classification appended to each class or group, and a bibliography of the most important and recent authorities, which will in most cases give the names of all other accounts worth reading. The two latter features are additions which Prof. Rolleston desired to be made in this edition, and the third chief item of his plan was to enlarge the descriptions of the preparations and accounts of the various classes of animals, and bring them up to the standard of contemporary knowledge. All this has been carried out by Prof. Jackson, though the great length of time which has elapsed since the publication of the first edition has brought with it so many and such vast changes in comparative anatomy that great labor and consequent delay became inevitable.

A CRITICAL HISTORY OF SUNDAY LEGISLATION FROM 321 TO 1888 A. D. By A. H. LEWIS, D. D. New York: D. Appleton & Co. Pp. 279. Price, $1.25.

DR. LEWIS has had occasion to make extensive studies of the Sunday question and its history, and particularly of the substitution in the Christian Church of the first day for the original Sabbath of the seventh day. The fruits of these studies are partly embodied in polemical works which he has written in maintenance of the doctrines and practice of the seventh-day Christians; but

outside of arguments and above them are facts in the form of official documents, civil and ecclesiastical, representing different periods of the history of the Church, that help to show how the prevailing notions and usages regarding Sunday have grown up and been fortified, and are, therefore, of general interest. These facts, which are established by full quotations from the original rescripts, are held to illustrate the real nature of the Sunday question of to-day, and to be fitted to guide to a way of dealing with it; for, the author says, "Every effort to remodel existing Sunday legislation, or to forecast its future, must be made in the light of the past." From the setting forth of the compilation, Dr. Lewis draws the conclusion that the first Sunday legislation was the product of that pagan conception of the Romans which made religion a department of the state. It appears in the form of an edict by Constantine as Pontifex Maximus, A. D. 321, ordering the observance of "the venerable day of the sun," in which no reference is made to Christianity. The first designation of this day of the sun as "the Lord's Day" appears sixty-five years later, or in A. D. 386, in connection with the mention of pagan and imperial holidays "baptized with new names and slightly modified. . . . During the middle ages Sunday legislation took on a more Judaistic type, under the plea of analogy, whereby civil authorities claimed the right to legislate in religious matters, after the manner of the Jewish theocracy." The Continental Reformation made little change in the civil legislation on the subject. The early Anglo-Saxon laws were historically, and therefore, probably, logically, the product of the middle age legislation of the "Holy Roman Empire." "The English laws are an expansion of the Saxon, and the American are a transcript of the English." Thus the author believes that he traces a historic continuity in the legislation from paganism till to-day. "In the Sunday legislation of the Roman Empire, the religious element was subordinate to the civil. In the middle ages, under Cromwell, and during our colonial period, the Church was practically supreme." Any claim that Sunday legislation is not based on religious ground "is contradicted by the facts of all the centuries. Every Sunday law sprang from a religious sentiment"; originally pagan, then gradually modified by the interweaving of the Christian idea of commemorating Christ's resurrection; then in the middle ages making a substitution of Sunday for the Sabbath of the Jewish theocracy. The historical review concludes with analyses of the Sunday laws of the several United States. While argument on Sunday legislation is not intended, the bearing of the book is against it as not being a function of political government; except so far as to preserve civil order, and particularly to repress the liquor-traffic on the day, the leisure of which gives so many opportunities for rioting and criminality.

PRINCIPLES AND PRACTICE OF MORALITY. By EZEKIEL GILMAN ROBINSON. Boston: De Silver, Rogers & Co. Pp. 264. Price, $1.50.

THIS treatise is designed as a text-book, and has grown out of the lectures which the author—who is President of Brown University—has given to his classes in ethics, when no existing text-book was found sufficient for the occasion. Ethical theories have been modified to a marked degree by the exhaustive discussions to which they have been subjected in recent years; and the resultant changes do not pass unobserved in the treatise, but are kept in mind when not formally referred to. Yet existing controversies are touched upon only so far as is necessary for the elucidation or defense of the positions here taken. Distinction is made between the science and the philosophy of ethics, the former being regarded as that which teaches what is moral, the latter as illustrating why it is moral. This brings up the consideration of the sources of moral obligation, or, as the author expresses it, with some originality of language, "the origin of the feeling of oughtness," to which considerable prominence is given, and in the discussion of which may be found the central point of Dr. Robinson's theory. The later theories on this subject—designated as the Hegelian, which makes the standard one of general contemporary recognition, or conventional; the evolutionary, which supposes it to have been developed or evolved; and the historical, which assumes it to be the fruit of experience—are declared insufficient to account for it. While the last two

theories may explain how moral laws and their sanction became known, neither of them goes to their origin; neither explains the imperativeness with which recognized moral law speaks to the human heart. Likewise, no final reason for the enforcement of moral obligation can be found in a Supreme Will, or in the beneficent ends which may be regarded as resulting from actions, or in the egoistic principles, whether rationalist, æsthetic, or sentimental, as are implied in other theories. The real ground of moral obligation is held to lie in the eternal nature of God—"in the immutable moral nature of the Supreme Personal Being who is the original and archetype of all human beings." Of the three parts into which the body of the book is divided, the first is devoted to the ascertainment and distribution of fundamental principles; the second to a discussion of those principles, under the general heading of "Theoretic Morality"; and the third to practical morality.

THE MANUAL TRAINING SCHOOL. By C. M. WOODWARD, Ph. D. Boston: D. C. Heath & Co. Pp. 366. Price, $2.

No one can read Prof. Woodward's book without getting from it an interest in the aims of the manual training schools of America, a belief in their methods, and a respect for their results. The author, who has been director of the Manual Training School of Washington University, in St. Louis, since its organization in 1880, naturally has most to tell about the history and experience of that institution, but he gives much information also about manual training schools of other cities in this country, and similar schools which he has visited abroad. He describes the fittings and tools which the workshops should have, also many suitable exercises in drawing, in bench-work, turning, and carving in wood, and in forging, foundry-work, and machine-shop work, all of which is illustrated with sketches and drawings. The St. Louis school is too young to have much of a record in the success of its graduates in their life-callings, many of them at the time of writing of this book being still students in higher institutions; but the director has collected enough replies to a circular letter to show that those graduates who have been employed beside young men without such training have generally taken higher positions and pay, while their capableness has disposed their employers to prefer such graduates over other applicants for employment. Several addresses given by the author at various times and places, and dealing with special features of the subject, are incorporated in this volume. The closing chapter and the appendices contain plans of the buildings occupied by the schools of St. Louis and Toledo, the courses of study in those schools, and suggestions in regard to administration.

Artistic Modern Houses at Low Cost, by *R. W. Shoppell* (Co-operative Building Association, New York, 25 cents), gives sixty designs, with plans, etc., including those designs the general types of which have pleased the largest number of customers, selected from the other books published by the Association. The estimates of cost range from $650 to $3,875; and the publishers guarantee that the actual cost of construction in each case shall be covered by the estimates which they are prepared to furnish, with detailed plans and specifications.

The Drainage of a House, by *William Paul Gerhard*, C. E. (Boston, Rand-Avery Company), embodies in a neat pocket pamphlet of fifteen pages a summary of the objects to be sought, and the general principles to be observed in providing for drainage and the removal and disposal of all waste waters from the house.

Four prizes were offered by Mr. Henry Lomb, of Rochester, N. Y., several months ago, through the American Public Health Association, for as many "best" essays on designated subjects relative to the health of families, school-children, and workmen. The essays to which the prizes were awarded have been published by the Association in separate pamphlets, at ten and five cents each, and together, in a bound volume, thoroughly indexed, at fifty cents. They are *Healthy Homes and Foods for the Working-Classes*, by *Victor C. Vaughan*, M. D., in which are considered the location, adaptation to it, arrangement, heating and ventilation, water-supply and disposal of waste, care, and all other points about the house in which questions of health may be involved, and discussions of the value and healthful-

ness of the various animal and vegetable foods.—*The Sanitary Conditions and Necessities of School-Houses and School-Life*, by *D. F. Lincoln*, M. D., in which the various features of school-house construction are considered from the point of their bearing on the health of pupils, and the care of the eyes, seats, desks, and positions, physical training, and the effects of school-life and school-work on the nervous system are especially considered.—*Disinfection and Individual Prophylaxis against Infectious Diseases*, by *George M. Sternberg*, M. D., U. S. Army; and *The Preventable Causes of Diseases, Injury, and Death in American Manufactories and Workshops, and the best Means and Appliances for preventing and avoiding them*, by *George H. Ireland*. These essays are written from the practical point of view, and for the purpose of being read and acted upon by plain men, with style and matter well adapted to that object. They are published by Irving A. Watson, Secretary of the American Public Health Association, Concord, N. H., and the American News Company, New York.

In the *Practical Lessons in the Use of English for Primary and Grammar Schools*, by *Mary F. Hyde* (D. C. Heath & Co.), instruction in composition is expected to be begun in the third year primary. The scheme of the lessons is intended to be progressive, and to involve constant practice in the correct use of all the parts of speech, the placing of the words in their proper relations, and the right employment of the usual punctuation-marks. The aim has been to lead the pupil to see for himself, to direct his attention to the use of language as the expression of thought, and to teach him to avoid errors by being trained from the first to use correct forms—not by placing before him incorrect forms for correction. These purposes are well brought out. The study is not confined to detached sentences, but passages from good writers are also introduced.

We have already commended the cumulative method of teaching languages of Prof. *Adolphe Dreyspring*. In the *First German Reader*, on this method (New York, D. Appleton & Co., 70 cents), the author has constructed a narrative presenting the varied activities of childhood in plain, simple, and facile language, with rapid succession of interesting and critical events, and the additional attractions of frequent, simple, but expressive outline illustrations. The motto of the cumulative system, "Repetition the mother of studies," is faithfully adhered to. The style of the narrative is flowing and pure, the vocabulary is limited, and every effort has been made by the author to compose a book which young students will like, and to make the road to knowledge as free from difficulties as possible.

The practical part of the *Geography for Schools*, by *Alfred Hughes* (Clarendon Press, Oxford, England; Macmillan & Co., New York, 50 cents), is based on the results of several years' experience at the Manchester Grammar-School. It consists chiefly in the inclusion of problems to be worked out by the pupil, which depend largely upon reference to the atlas and the use of common mathematical knowledge. The problems involve questions of latitude and longitude, distances on the earth's surface, the rotation of the earth, the apparent movements of the fixed stars and of the sun, the seasons, altitudes of the sun, length of day and night, movements of the earth, length of shadows, etc. The constant references to the atlas required are found useful in promoting the knowledge of descriptive geography.

Robert Seidel's work on *Industrial Instruction*, which has been translated by *Margaret K. Smith* (Heath, 80 cents), is a defense of manual training against objections raised against it in the Synod of the Canton of Zurich, in 1882 and 1884. The author maintains that industrial instruction has "a great educational value; a significant mental and physical disciplining power; and a deep-reaching social and moralizing influence."

Slips of Tongue and Pen, by *J. H. Long* (Appleton, 60 cents), is a convenient little manual, which points out many common errors of speech and writing, explains the appropriate uses of words often confused, and includes suggestions on composition and notes on punctuation. The matter is arranged more attractively than in the regular style of reference-books, and illustrations are given of both the correct and the incorrect uses of the words treated.

The pamphlet on *Seminary Libraries and University Extension*, by *Herbert B.*

Adams, of Johns Hopkins University (N. Murray, 25 cents), gives an account of the German practice, which is spreading among American universities, of making special collections of books for the use of students in special branches of study. It contains also a short paper advocating the extension of the system to public reference libraries, in connection with courses of lectures, and another describing the similar practice arising in England under the name of university extension.

Mr. *Edward Potts's* monograph on *Fresh-Water Sponges* (Philadelphia: *Academy of Natural Sciences*) has been prepared for the purpose of describing genera and species, mostly North American, that have been discovered since the publication of Mr. Coates's "Description and Classification" (London) in 1881; to give the results of the examination of the character and variations of already known North American species, and for use as a book of reference on all "good" species. The author further hopes to revive, among lovers of Nature, the appreciation of the existence of sponges in our fresh waters; and to show how to find, collect, classify, and preserve them.

Skeleton Notes upon Inorganic Chemistry, by *P. de P. Ricketts* and *S. H. Russell* (John Wiley & Sons, New York), is a book of blanks for preserving notes of lectures, experiments, or studies. The present volume is labeled Part I, and is devoted to the non-metallic elements. A definite number of pages is allotted to each element, the section being preceded by a table giving the ascertained constants and properties of the element, its applications, and its principal binary compounds.

Of the *Course of Lectures on Electricity* by *George Forbes* (Longmans, Green & Co., London and New York, $1.50), five were delivered in 1886 before the London Society of Arts, and the sixth—which shows the applications of the general principles to one department of practical engineering—was delivered at the Electrical Exhibition in Philadelphia in 1884. The lectures were intended to meet the desires of an intelligent audience, ignorant of electrical science, but anxious to obtain sufficient knowledge to enable them to follow the progress now being made in it; and the attempt is made to present in clear language the fundamental facts governing electrical phenomena in such a manner as will leave the reader nothing to unlearn.

In *Loomis's Contributions to Meteorology Reviewed* (K. Kittredge, Ann Arbor, Mich., 50 cents), *H. Helm Clayton* has compiled a summary of the series of papers which Prof. Loomis has published in the "American Journal of Science and Arts," and which are collectively pronounced "one of the best pieces of work in inductive meteorology of the present age." This summary, covering the chief results of the discussions, is intended for those persons who have not access to the papers in their complete form.

The *Conferencias Filosóficas*, or Philosophical Lectures; second series, Psychology, of *Enrique José Varona* (Havana), comprises a series of thirty lectures which were given in the Academy of Medical, Physical, and Natural Sciences of Havana in 1880 and 1881, and have been already printed in various numbers of the "Revista de Cuba." The opening lectures explain the general principles and foundations of the science, and the importance of the phenomena of movement to its study. They are followed by discussions of the various corporal senses in their order, and then by their relations and qualities of sensation and perception, memory, representation, association, imagination, the emotions and sentiments, the processes of determining and acting, suggestions respecting classification, and a bibliography.

Prof. *Balfour Stewart* and *W. W. H. Gee* have undertaken a series of small books on *Practical Physics*, of which vol. i, *Electricity and Magnetism* (Macmillan, 60 cents), has already been issued. This volume is based on the one devoted to the same subject in the "Elementary Lessons in Practical Physics" by the same authors. It is a laboratory manual, consisting largely of simple experiments and measurements in electrostatics, magnetism, and current electricity, the principles of which are at the same time explained to the student. In order to make the book complete in itself, a chapter is inserted describing the use of scales, calipers, wire-gauges, the balance, etc. In the appendix will be found plans of certain school laboratories, a list of apparatus, tools, and materials, and other information that should be

of value to the teacher. The book is designed for schools and the junior students of colleges, and is intended to facilitate the employment of practical physics as a training for the mind.

Under the title *The Child and Nature*, a book has been issued by *Alex. E. Frye* (Bay State Publishing Co., Hyde Park, Mass.), setting forth a method of teaching geography in which sand-modeling is an important feature. The author maintains that pupils should be led to regard the land areas as possessing not only length and breadth, but also the very important dimension of height, "which divides the surface into the great slopes that form the river-basins, determine rainfall and drainage, distribute soil as food for plants, and thus prepare the earth to become the home of man." He advises that the study begin with modeling the district about the school-house, and shows by illustrative lessons and lists of questions how ideas of the forces acting upon land and water, of the plant and animal life, and of human occupations and interests in the vicinity, may be developed. As the next step he puts the study of the earth's surface as a whole, "first, because the globe is the *simplest* whole; and, second, because the globe study alone can lead to those relations to heat, winds, and rainfall which enable the pupil to take the next step in the science." The continents, he says, should be studied later as parts of the globe structure. As with the district, he shows how the subjects of forces, life, and man are to be taught in the department of foreign geography.

Three Kingdoms: a Handbook of the Agassiz Association, by *Harlan H. Ballard* (Writers' Publishing Co., New York, 75 cents), was written "to serve instead of a personal reply to the inquiries concerning the Agassiz Association." It comprises first an account of the organization, whose object is to aid young people in the collection, study, and preserving of natural objects and facts; then directions for organizing a chapter of the Association and a plan of work. In the following chapters are given suggestions for work with plants, insects, birds and their eggs, minerals, and archæological specimens. Exchanging specimens, books to read, taking notes, more about the Association, and various hints and helps, occupy the remaining chapters.

The first of a series of "Nature Readers," with the title *Sea-side and Way-side*, has been written by *Julia McNair Wright* (Heath, 25 cents). It is intended for children who are beginning to read, and consists of descriptions in simple language of the structure and habits of insects and shell-fish, its peculiar aim being to interest the child in natural objects while he is learning to read.

Profs. *Oscar Oldberg* and *John H. Long* have published *A Laboratory Manual of Chemistry* (W. T. Keener, $3.50), for students of medicine and pharmacy. As described in the preface, "it contains experiments intended to familiarize the student with the properties of the principal elements, lessons in synthetical chemistry, a systematic course in qualitative analysis, examples in quantitative determinations, including the official methods of assay for a few important drugs, and a short chapter on the chemical and microscopical examination of urine." An appendix contains lists of apparatus and reagents, and tables of weights, solubilities, etc. The volume is illustrated with figures of apparatus, and plates showing the appearance of various crystals, corpuscles, casts, etc.

Photography applied to Surveying, by Lieutenant *Henry A. Reed*, U. S. A. (Wiley, $2.50), is a treatise on a subject on which little seems to have been yet published outside of France. The author, having been strongly impressed with the value of photography in his own practice, has prepared an account of the method for the use of surveyors in this country. He describes the instruments and materials required, and the mode of procedure, in the methods by plane perspectives, cylindric and radial perspectives, and gives an account of telescopic and balloon photography. He states as the advantages of photographic surveying that the field-work may be performed with great rapidity, and with an economy of men and material unattainable by other means; there is no fear of having omitted some important point, and no occasion for rejecting doubtful observations; the plotting presents no difficulties, and abundant means of checking results are afforded. The volume is a thin quarto, and is illustrated with fifty-eight cuts and a photographic map.

Dr. *C. W. Dulles's* little manual on *Accidents and Emergencies* (Blakiston, 75 cents) has reached a third edition. It has been revised and enlarged, and new illustrations have been added. The aim of this book is not to take the place of calling a physician or surgeon, but to fill up with helpful action the interval before skilled assistance arrives. It contains information which every one is liable to have a sudden need for during the present season of travel and more or less dangerous sports.

From the same publishers comes the sixth American edition of Dr. *T. H. Tanner's Memoranda on Poisons* (75 cents), which has been revised by Henry Leffmann, M. D. Obsolete portions of the text have been omitted, and some new matters of importance have been added. The toxicology of poisonous food has been rewritten. This manual is for the medical practitioner, and contains, besides directions for the diagnosis and treatment of poisoning, also a statement of his duties with reference to obtaining information for a judicial inquiry.

Mr. *F. B. Goddard* has written three pamphlets for the guidance of the householder, dealing with *Furniture and the Art of Furnishing*, *Marketing*, and *Grocer's Goods* (Tradesman's Publishing Co., New York, each 20 cents). They are full of practical information in regard to qualities, imitations, prices, uses, and care of the various goods and supplies described, which will save the inexperienced buyer many times the cost of the pamphlets.

The Story of New York, by *Elbridge S. Brooks* (Lothrop, $1.50), is the first volume in "The Story of the States" series. It aims to give the reader an acquaintance with its field, by presenting to him the stages of growth through which the State of New York has passed. The progress of the average citizen through the changes of over two hundred years is represented by the story of a hypothetical Knickerbocker family, which is woven in with the historical data. The author has been more solicitous to make a readable book than to crowd a great number of facts into a small space, and is much aided in this respect by the many illustrations.

The negro literature of our Southern plantations has been increased by a volume of *Negro Myths from the Georgia Coast*, which have been recorded by *Charles C. Jones, Jr.* (Houghton, Mifflin & Co., $1). The stories of the negroes in the swamp region of Georgia and the Carolinas have a character of their own, differing from those in vogue among the negroes of middle Georgia, which have been recounted by Mr. Joel Chandler Harris. The stories of this collection are short, and are told in vernacular. A glossary is appended to the volume.

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POPULAR MISCELLANY.

The Organization of the Geological Survey.—The statement of the organization, business methods, and work of the Geological Survey, prepared by Major J. W. Powell, the director, in response to the inquiries of the Senate Select Committee on the Executive Departments, gives a very detailed account of that bureau. The Survey was organized in March, 1879, with Mr. Clarence King as director, who was succeeded in March, 1881, by Major Powell. The function of the Survey is "the geological survey and the classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain, and to continue the preparation of a geological map of the United States." For the prosecution of these researches, there have been organized a division of geography, divided into several sections, a number of divisions of geology and paleontology, and several miscellaneous divisions, namely, chemistry and physics, petrography, mining statistics and technology, forestry, illustrations, and library and documents. The funds for the support of the Survey are appropriated by Congress from year to year, the amount for the current fiscal year being $502,240. Before the beginning of each year the plan for the year is formulated by the director, after conference with the heads of the various divisions and sections, and a stated sum is allotted to each head officer for prosecuting the work in his charge. In large measure each chief is an independent investigator, and, since all reports or maps made by him are published under his name, he has a strong incentive to do all that can be done with the money allotted; his work, however, is under the general supervision and control of the director. The fiscal operations of the Survey are in charge of a chief disbursing clerk, and there are twelve disbursing agents acting under his general direction. Nine of these belong to the scientific staff, and merely add the labor of disbursing to their other duties. There is also a class of agents, made up mainly of chiefs of divisions and their scientific assistants, who are charged with the custody of all property owned by the Survey. This class of agents is made so large that each individual may have personal knowledge of every article with which he is charged. Collections of minerals made for study in the several divisions are ultimately transferred to the United States National Museum, with the exception of material that would be useless in a museum. In the division of illustrations, a number of assistants are employed upon drawings and the proof-reading of engravings. There is a photographic laboratory belonging to the division in charge of a photographer who has four assistants. This force does not include that employed in the section of topographic drawing in the division of geography. The labor of preparing the manuscripts for the

press, and of careful reading of the proofs of the large amount of the Survey's publications, has made necessary the development of an editorial system. During the year 1886–'87 there was published an aggregate of 4,253 pages of text, illustrated by 350 plates and 327 figures. These publications consist of four classes, viz., annual reports, monographs, bulletins, and statistical papers. At the date of this statement, five annual reports, eleven monographs, thirty-five bulletins, and two statistical papers had been issued. The monographs are in quarto form, the other books in octavo. The custody of the documents distributed through the Survey is vested in the librarian, and accounts are kept of the number of copies received from the public printer, and sold, exchanged, or given away. A printed letter of transmittal, with a blank receipt and an envelope for its return, is sent out with each copy. The Survey maintains a geologic library for use in the prosecution of its work. The library last year contained 19,501 volumes, 26,100 pamphlets, and 8,000 maps. The facilities afforded by this collection are being utilized in the preparation of two geologic bibliographies by the library staff. The librarian has eleven assistants. In the principal office of the Survey, at Washington, there are employed in the work of the Survey from 70 persons in summer to 225 persons in winter, in a building of 78 rooms, on five floors.

"Feeding for Fat and for Lean."—Dr. Manly Miles, criticising the reports under the above title of experiments in pig-feeding made at the Missouri Agricultural College, and the Wisconsin Agricultural Experiment Station, fails to find any practical results in them which are both new and reliable. He quotes some of the results obtained in the extended feeding experiments conducted by Sir John Lawes and Dr. Gilbert at Rothamsted, and points out, among the indications which they give, that the nitrogenous substance of the animal's increase in weight bears no direct relation to the amount of nitrogenous substance of the food consumed. Also, in the words of the experimenters, "that, with an excessive proportion of nitrogenous substance in the food of the fattening pig, we have found there was more of a tendency to grow in frame or flesh, than in other cases; and again, that the larger the proportion of flesh in the increase, the less will be the proportion in it of real dry substance." Further, when fattening foods contain an ordinary amount of nitrogenous substance, "it is their available non-nitrogenous constituents which rule both the amount of the food consumed and the increase in live weight produced." The pigs fed on corn-meal exclusively at Rothamsted did not do well until a mixture of coal-ashes, salt, and superphosphate of lime was given them, but this gave the most satisfactory results both as to the health of the animals and their progress in feeding. In the Missouri and Wisconsin reports of experiments, little attention is given to the proportion of mineral constituents in the food, which Dr. Miles deems an important omission, especially in the case of growing animals, that should make some increase in bony tissue. He regards corn-meal as undoubtedly deficient in ash constituents, and his own experience has been that, when feeding it alone, the most satisfactory development of muscle as well as bone has been obtained when the pigs had access to some bone-ash, leached wood-ashes, or other similar mineral matters. It is likewise a common practice among farmers of his acquaintance to provide some mineral "relishes" for their pigs when their food consists largely of corn.

Execution by Electricity.—The new law of the State of New York substituting execution by electricity for hanging was drawn in conformity with the report of a commission, consisting of Elbridge T. Gerry, Alfred P. Southwick, and Matthew Hale, which was appointed by the Legislature to investigate the most humane method of inflicting the death-penalty. The report contains, first, a brief history of capital punishment from the time of Moses to the present day; second, objections to the five modes of execution now employed by civilized governments, followed by a discussion of proposed substitutes, with a recommendation of electricity. From the opinions of experts and the results of experiments on dogs, the commission concluded that "death produced by a sufficiently powerful electric current is the most rapid and humane produced by any

agent at our command," and that "the apparatus to be used should be arranged to permit the current to pass through the centers of function and intelligence in the brain," resuscitation under such conditions being impossible. As to the appliances, the commission said: "All that would be essential would be a chair with a head- and foot-rest, in which the condemned could be seated in a semi-reclining position; one electrode would be connected with the head-rest, and the other with the foot-rest, which would consist of a metal plate." The current of electricity might be supplied from the wires used for street-lighting, or from an independent plant at the place of execution. The most effective machines for the purpose are those known as "alternating machines."

Mound-Builders' Units of Measure.—Mr. R. P. Gregg, of Buntingford, Herts, England, has made investigations concerning the units of measure among certain ancient nations, including those of America. He concludes that the Peruvians of the time of the Incas, the Aztecs, Toltecs, and Central Americans, employed a common measure, comprising a foot equal to $11\frac{3}{4}$ inches English, or a fraction more than the old Roman or Solon's foot, which foot, = 0·298 of a metre, was divided into twelve equal parts. These feet, being to English feet as 100 : 102, are reducible by simply adding two per cent. The mound-builders' measure, as derived from a curious tablet found in Cincinnati in 1841, and from implements described by Dr. Abbott and the investigators of Ohio mounds, consisted of a foot equal to ten English inches, or 0·254 metres, which was divided into twelve mound-builders' inches, seven of which were equivalent to six Mexican inches. Incidentally, the author has reason to suppose also that the mound-builders' acre, or larger unit of superficial measure, was equal to from $1\frac{3}{8}$ to $1\frac{7}{16}$ English acre, with square side of 300 mound or 250 English feet, and that the favorite square and circle areas of 20, 27, and 40 (or 41) acres English, meant 15, 20, and 30 mound acres respectively. A third unit was the prehistoric measure of North America, the inch of which was intermediate between the mound inch and the Mexican inch, and of which the author is not certain whether there were eleven or twelve to the foot. As no mound-builders' measures have so far been found in Central America, Peru, or Mexico, that people are apparently excluded from the presumption of ever having lived there; but from the occurrence of the southern measures along with those of the mound-builders in the latter's country, it would seem to follow "that the mound-builders, and the people allied to, or the ancestors of, the Toltecs, etc., must have, perhaps some two thousand years ago, coexisted and lived together in large parts of America, extending from New York to Ohio and Tennessee, and not been exclusively confined to the mound districts *par excellence*."

Flower-Farming.—Flower-farming and the manufacture of essences constitute a special industry in southern France. The principal center of the business is at Grasse, in the *Alpes Maritimes*, but it branches out into other districts. The flowers grown include the violet and jonquil, which are gathered in winter or early spring, roses, orange-blossoms, thyme, and rosemary, in May and June, jasmines and tuberoses in July and August, lavender and spikenard in September, and the acacia in October and November, so that the season may cover three quarters of the year. Thyme, rosemary, and lavender are usually side-products, grown by farmers of the grape and olive, who distill from them inferior essences, which are used to dilute and adulterate those of superior quality. According to Consul Mason, of Marseilles, the best situations for growing perfume flowers are at altitudes of from five hundred to two thousand feet. Flowers grown on such elevated positions are said to be richer in perfume than similar varieties that bloom in valleys and lowlands. The plantations want to be provided with a soil rich in calcareous elements, and to be sheltered from cold winds. The rainfall being scanty, irrigation is necessary. All fancy and "improved" varieties of flowers are discarded, and the natural, simple, old-fashioned kinds alone are grown. Middlemen go through the flower districts every day during the season, and deliver the flowers to the distillers while they are yet fresh and crisp. The manufacture of perfumes includes the making of pomades and

oils by the process of absorption, and of essences and essential oils by distillation. To make pomade, a square frame or *chassis* of white wood, about twenty by thirty inches, is set with a pane of strong plate glass. On either side of the glass is spread a thin, even layer of purified and refined grease. These frames are prepared beforehand, and kept for the time of the flowers. This having arrived, the petals are picked from the blossoms and laid so as to cover the grease in each frame. These are piled one upon another so as to fit closely together, when there is formed a kind of tight chamber, the floors and ceilings of which are of grease exposed to the perfume of the flower-petals within. The grease absorbs the perfume, while the spent flowers are removed daily and fresh ones supplied for two, four, or five months, according to the strength of perfume desired in the pomade. The perfume may afterward be extracted from the pomade by alcohol, when it becomes a floral water or extract. Coarser pomades are made by boiling the flowers in the grease, and subjecting the residue to pressure. The spent pomades are used for toilet purposes, and in the manufacture of fine soaps. When perfumed oils are wanted, superfine olive-oil is used, and cotton cloths saturated with it take the place in the *chassis* piles of the grease coating on the glass. Essences and scents are produced by ordinary distillation.

The Best Asphalt.—No artificial mixture of bitumen and calcareous matter, says Mr. W. Y. Dent, in a lecture before the Society of Arts, is so well adapted for the description of asphalt used for road-making purposes as the natural deposits found at Val de Travers and at Seyssel. Its superiority is possibly due to the perfect manner in which, by the enormous pressure to which the deposits have been subjected, the ingredients of the rock have been incorporated. The native asphalt rock consists for the most part of carbonate of lime, more or less impregnated with bitumen, the quantity of which varies from about six to twelve per cent, that from the Val de Travers, in the canton of Neufchâtel, containing rather more bitumen than that of the Seyssel. The prepared asphalt, as sold by the makers under the name of "mastic," is made by crushing the asphalt rock under a steam-hammer and grinding it to powder by edge-runners. The powdered rock is then carried forward by means of an endless screw to cast-iron vessels placed over a fire, in which it is mixed with suitable proportions of fine sand and bitumen and kept constantly stirred for two or three hours, when it is run into blocks weighing about one hundred and twenty pounds. When the mastic is used it is reheated with more bitumen, and coarse sand is added to it in quantities, according to the purpose to which it is to be applied. Coal-tar pitch is not an entirely satisfactory substitute for bitumen in this mastic, because when hard it is too brittle, and when warm is too soft and sticky.

Geography and its Related Sciences.—Mr. H. J. Mackinder would define geography as the science whose main function is to trace the interaction of man in society, and so much of his environment as varies locally. According to Mr. Bryce, the environment comprises the influences due to the configuration of the earth's surface; those belonging to meteorology and climate; and the products which a country offers to human industry. The first of these categories depends more largely than has been acknowledged on geology, and is related to physiography, which asks, "Why is it?" to topography, which asks, "Where is it?" to physical geography, "Why is it there?" and to political geography, "How does it act on man in society, and how does he react on it?" and itself asks, "What riddle of the past does it help to solve?" We may stop short at any of these questions, but can hardly answer a later one with advantage unless those which preceded it have been answered. Of meteorology, average or recurrent climatic conditions alone—not weather-forecasting—come within the geographer's ken. In considering the productions of a region, the distribution of minerals is incidental to the rock structure. The distribution of animals and plants is pertinent in so far as those organisms form an appreciable factor in man's environment, and in so far as it gives evidence of geographical changes, such as the separation of islands from continents and the retirement of the snow-line. But the study of the distribution of animals

and plants in detail, and as illustrating evolution, is in no sense a part of geography. Geography and history are related in their elementary stages, but diverge in their higher stages. The geographer must furnish to the historian the ideas and facts in science which he requires, and must go to the historian for the verification of the relations which he suggests. The body of laws governing those relations, which might in time be evolved, would render possible the writing of much "prehistoric" history. Mr. Green's "Making of England" is largely a deduction from geographical conditions of what must have been the course of history.

Water-Spouts in the Atlantic.—Many interesting reports in regard to water-spouts, sighted by masters of vessels during January and February off the Atlantic coast of the United States, have been received by the Hydrographic Office of the Navy Department. Water-spouts are a special class of whirlwinds, and their manner of formation is described as follows in a supplement to the "Pilot Chart of the North Atlantic Ocean" for March: "A layer of warm, moist air at the surface of the ocean happens to have above it a layer of cooler, drier air. This condition of things is one of unstable equilibrium, and sooner or later the warm, light air at the surface rises through the cooler and heavier air above. This process sometimes takes place gradually over large areas, but at other times it is more local, and there seems to be formed in the upper layer a break or opening through which the air of the lower layer begins to drain upward, as through a funnel. Under favorable conditions—that is, when the differences of temperature and moisture and the supply of warm, moist air at the surface are great—this action becomes very intense, and this intensity is still further increased by the fact that as the air rises its moisture is condensed, the latent heat thus liberated adding to the energy of the rising column of air. Now, as this surface air rushes in and escapes upward through the opening thus formed in the upper layer, it takes up a rotary or whirling motion, the velocity of which increases toward the center or axis of the funnel, and a suction or partial vacuum is created, as indicated by the low reading of the barometer at the center of a cyclone or whirlwind. When a whirlwind is thus formed over the ocean, water is often drawn up the center of the whirl some distance, owing to the suction created, and at the same time the moisture in the air is condensed as it rises, so that the name 'water-spout' is very applicable. Indeed, sometimes a spout will burst over a vessel and flood her decks with water, as a cloud-burst does a mountain-side. When a spout is forming, its upper portion is often visible first, seeming to grow downward from the clouds. By observing carefully with a telescope, however, it will be seen that the motion in the column itself is upward, although the moisture in the air which is rising is condensed lower and lower down, thus rendering the whirl visible lower down continually, and making it appear to be actually descending." That part of the North Atlantic from Cuba to the latitude of Philadelphia, and from the Atlantic coast of the United States to the Bermudas, is pre-eminently a region where water-spouts are liable to occur, owing largely to the warm, moist air lying upon the Gulf Stream, and the cool, dry air brought over it by the northwesterly winds from off the coast. Most of the water-spouts referred to were seen within this region. The Office wishes to receive many full and accurate reports of such marine phenomena, in order that knowledge of them may be increased. The most important observations regarding a water-spout are the temperature of the air and water, the reading of the barometer, direction and force of the wind, and the changes which take place in each while the spout lasts; also, the direction of rotation of the whirl, and an estimate of its size, character, and changes of form, with, if possible, photographs or sketches, however rough, of its appearance at the various stages of its formation and progress.

An Ancient Human Foot-print.—The discovery of human foot-prints in volcanic rocks near the shore of Lake Managua, Nicaragua, under circumstances which seemed to assign them a remote antiquity, has been announced for several years. Dr. D. G. Brinton has described, in a paper read before the American Philosophical Society, a specimen of these foot-prints, sent to him by Dr. Earl Flint, of Rivas, Nicaragua. The volcano of

Tizcapa, which furnished the material forming the tufas on which the foot-prints occur, is one of several in the vicinity which have long been extinct, and whose craters are occupied by deep and still lakes. Dr. Brinton's specimen was taken from a quarry on the lake-shore at a point where the overlying strata present a thickness of twenty-one feet beneath the surface soil. These strata comprise five well-marked beds of tufa, beneath which is a deposit of clay, and below this four more beds, with other accumulations in the seams, of pumice and volcanic sand. A heavy deposit of tufa, lying on yellow sand, is then reached. This is the last in the series, and bears on its upper surface innumerable foot-prints—some deeply imprinted, while others are but superficial impressions. As to the age of the foot-prints, Dr. Flint believes the yellow sand under them to be Eocene, but the small shells which it contains are deemed by Prof. Angelo Heilprin to be more nearly Post-pliocene than Eocene. In view of this, and the indications furnished by the overlying strata, Dr. Brinton concludes that there is not sufficient evidence to remove the foot-prints further back than the present Post-pliocene or Quaternary period.

The Lake-Age in Ohio.—Prof. E. W. Claypole has investigated the series of events that occurred in Ohio and the adjoining region during the final retreat of the North American glacier, and has thrown into one view what is known of these occurrences. The terminal moraine of the great glacier crosses the eastern boundary of Ohio a little north of the Ohio River, and extends west and southwest, crossing the Ohio River near Cincinnati. The ice here dammed the river, and ponded back its waters for hundreds of miles. The banks of the Ohio at Cincinnati rise from four hundred to five hundred feet above the water; hence, in order that the ice may have been high enough to pass over into Kentucky, it must have had in the bed of the river a thickness of five hundred to six hundred feet. In this way was formed a lake, which Prof. Claypole calls Lake Ohio, occupying a large tract of the low lands on both sides of the main stream and its tributaries, extending on the north to the edge of the ice-sheet, and hence covering a large share of the southern and eastern parts of the State, reaching beyond the site of Pittsburgh, with arms running up the valleys of the Alleghany and Monongahela Rivers. Lake Ohio must have had a length of four hundred miles, measured in a straight line, and a width of two hundred. Its outlet was probably near Cincinnati, and followed the valleys of the Licking and Kentucky Rivers to that of the Ohio below the ice-dam. When the amelioration of the climate caused the great glacier to retreat northward, there must have come a time when the dam had melted down so that the water could flow over it. A channel was quickly cut in the ice, and the foundations of the dam were undermined. Finally, the dam broke, and all the accumulated water of Lake Ohio was poured through the gap. Days or even weeks must have passed before it was all gone, but at last the lake-bed was dry. When the ice-sheet had been pushed back north of the water-shed which separates the streams that flow into Lake Erie from those that flow into the Ohio River, the water that came from the melting of the ice was held between the front of the retreating ice and the ridge of the land. Thus in the valleys of the Cuyahoga, Sandusky, Maumee, and other north-flowing rivers, triangular lakes were formed with their bases resting against the ice-wall, and narrowing and shallowing back to the water-shed, where they found outlets in south-flowing rivers. All these lakes left monuments behind them in the form of beds of silt, in which are imbedded stones such as might be dropped by floating masses of ice. As the ice-line shrank back down the slope toward Lake Erie, the bases of these triangular lakes spread until they came in communication with each other, and the chain formed one continuous lake, using the lowest of the several southern outlets which had belonged to the separate lakes. As the bed of Lake Erie became uncovered by the glacier, this ancient lake increased in extent, and there is evidence which indicates that when the ice-sheet had retreated still farther the lake formed one vast sheet of water occupying the beds of Lakes Erie and Ontario, the southern part of the bed of Lake Huron, and much of the surrounding country. There was no escape for this water through the St. Lawrence River; that passage was still blocked by the ice. Where Fort Wayne, Ind., now stands, there is a gap

in the ancient margin of the lake, two hundred and twenty-five feet above the present level of Lake Erie, but one hundred feet lower than any of the outlets of the chain of triangular lakes which had been the nucleus of this great inland sea. Southwestward from this water-gap runs a broad but now almost deserted water-way communicating with the valley of the Wabash River, and by this passage the drainage of the "Erie-Ontario" basin found an outlet to the Mississippi.

The Head-Waters of the Orinoco.—The Guaharibos, an Indian tribe living near the head-waters of the Orinoco, are described by M. Chaffaujon as of small and mean stature, with slender limbs, stomach inordinately distended, long and coarse hair, and bestial physiognomy. They were absolutely nude, and carried nothing but a stick. Their repast consisted of palm-shoots, a quantity of half-rotten fruit, and some balls composed of white ants. Some others, to whom the traveler exhibited at a distance pieces of cloth, knives, etc., fled as soon as he attempted to get near them. The source of the Orinoco was found to be a mountain-torrent springing from a peak which was named Ferdinand de Lesseps, in the Sierra Parima range (3,300 feet high). M. Chaffaujon studied the remarkable bifurcation of the Orinoco by means of the Cassiquiare, whereby a connection is established with the Rio Negro and the Amazon, and found it to be the result of the undermining and washing away of the clay banks of the river during the rainy season. The outlet from the Orinoco descends a few inches every year, and is now nearly half a mile from its original position. In entering the Cassiquiare the current has the same force as that of the Orinoco, but quickly increases in rapidity after traversing the clay deposits. This communication between the two streams is believed to be recent.

The Progress of Cremation.—It is now fourteen years since Sir Henry Thompson proposed cremation as a method of disposing of the dead eminently desirable to be adopted on sanitary grounds. The proposition fell as a shock upon a large part of the public; and it may be recorded as among the curiosities of the human mind that, although there is no conceivable relation between cremation and religion, it was regarded by many persons high in the Church as a covert attack on Christianity. Yet it was not new; for it had been proposed in Italy in 1866, experimented upon by Gorini and Pollini, with published results in 1872, and illustrated, with the display of a model furnace at the Vienna Exhibition of 1873. The Cremation Society of England was formed in 1874. Opinions of legal authorities were obtained to the effect that the proposed process was not illegal, provided no nuisance was occasioned by it. An arrangement with one of the London cemeteries for the erection of a crematory on its grounds having been vetoed by the Bishop of Rochester, an independent property was obtained at Woking, on which a Gorini furnace was erected. A test of this apparatus, made by Prof. Gorini himself in 1879, showed that in it complete combustion of an adult human body could be effected in about an hour, so perfectly that no smoke or effluvia escaped from the chimney, every portion of organic matter being reduced to a pure, white, dry ash, absolutely free from anything disagreeable. Several cremations had in the mean time taken place abroad; one at Breslau and one at Dresden in 1874, and two at Milan in 1876. The Cremation Society of Milan was established in 1876, and soon became popular and influential. It erected a handsome building, with a gas, and afterward two Gorini furnaces, in which four hundred and sixty-three bodies were cremated to the end of 1886. Similar buildings have been built and used at Lodi, Cremona, Brescia, Padua, Varese, and Rome; and in all seven hundred and eighty-seven bodies have been cremated in Italy. The only place in Germany where the practice has been regularly followed is Gotha, where a building was constructed with the permission of the Government, in which four hundred and seventy-three cremations were performed from January, 1879, to the 31st of October, 1887. Cremation societies have been established in Denmark, Belgium, Switzerland, Holland, Sweden, and Norway, and in various parts of the United States. A crematory has been built in Paris, and was first used on the 22d of October last. The English crematory did not go into operation until 1884, after Mr. Justice Stephen had pronounced his judgment that the process was legal, if performed

without nuisance. Suitable provisions were made to obviate the only valid objection to the process—that it might be used to destroy evidences of poisoning—and the first cremation took place on the 20th of March, 1885. Two others followed in that year, ten more in 1886, and ten more to the end of November, 1887. "The complete incineration is accomplished," says Sir Henry Thompson, "without escape of smoke or other offensive product, and with extreme ease and rapidity. The ashes, which weigh about three pounds, are placed at the disposal of the friends, and are removed. Or, if desired, they may be restored at once to the soil, being now perfectly innocuous, if that mode of dealing with them is preferred. One friend of the deceased is always invited to be present, and in almost every instance has expressed satisfaction with the way in which the proceeding has been carried out." The Cremation Society has no thought of making cremation compulsory, but simply by all the means in its power to encourage its voluntary adoption, and to enlarge the opportunities for those who desire it to have their wishes properly carried out. It, however, urges upon all that cremation is eminently preferable—whatever may be the feelings in other respects—in the case of persons who have died of small-pox, scarlet fever, or diphtheria. All cases where the cause of death is in doubt should be rejected at once, except after an autopsy. If the autopsy is objected to by the family of the deceased, the cremationists would avoid the doubtful case without raising an imputation.

India-Paper.—India-paper, which the Chinese call *lehi*, is made from hemp, mulberry-bark, cotton, bamboo, rice-straw, barley-straw, and from the interior membrane of silk-worm cocoons. Sometimes the whole of the stalks of bamboo of a year's growth are used. The pulp is mixed, after it has been prepared, with a given proportion of a vegetable gum called *hotong* in China. The paper is molded in molds made of fine bamboo filament. Those sheets, sixty feet in length, which the Chinese are said to make, are supposed to be fabricated by artfully joining several small sheets at the moment of laying the paper. When taken from the molds, the paper is stretched upon a wall, hollow inside and heated, the surface of which has been coated with a very thin mastic. The application of the mastic is made with a brush, and this accounts for the streaks and roughness that appear on the wrong side of this paper. India-paper, being too thin to bear handling or any strain, is mounted on vellum, which serves as a lining to it, and the white borders of which set it off as a frame would do. The sheets thus prepared are kept in a dry place, far away from the fire, and may be preserved for years.

NOTES.

Prof. Daniel S. Martin has announced a "Geological Map of the Environs of New York City," embracing a region of sixty-eight miles from north to south, and fifty miles from east to west. It includes the whole width of the Triassic belt of New Jersey, with its trappean ridges entire, and its relations to the formations around it; the northern part of the entire series of the New Jersey State Survey's divisions of the Cretaceous; the recent divisions of the New Jersey and Long Island coast region; the Great Terminal Moraine conspicuously laid down; the lines of deep sounding, which mark the submerged pre-glacial channel of the Hudson River; and all other geological features. It measures forty by fifty inches, and is published at a subscription price of ten dollars a copy.

The fourth session of the International Geological Congress will be held in London, September 17th to 25th. Prof. Huxley will be honorary President, Prof. Prestwich President, and the President of the Geological Society, the Director of the Geological Survey, and Mr. T. McR. Hughes, Vice-Presidents. Messrs. T. W. Hulke and W. Topley are the General Secretaries, to the latter of whom communications respecting the Congress should be addressed, at 28 Jermyn Street, London, S. W.

A circular of the Educational Department of Scotland discourages attempts to give technical instruction in the primary schools till the boys have reached the higher standards, and not even then unless skilled teachers and scientific apparatus are attainable. In most instances the thorough teaching of elementary science is beyond the reach of the primary schools; but some of the difficulty may be overcome by several school boards uniting to employ a trained staff of teachers. School boards are advised to seek the aid of local committees composed of manufacturers who know what technical education is most needed in the district.

Dr. W. J. Holland, naturalist of the American Eclipse Expedition to Japan, collected 4,000 botanical specimens, representing nearly 800 species, and 6,000 entomological specimens, representing about 1,200 species, mainly Lepidoptera and Coleoptera. He obtained also by purchase the entire collection of Pyralidæ made by Mr. H. Pryer, representing the labors of nearly seventeen years, and containing nearly 4,000 specimens, of more than 375 species, the larger part of them as yet undetermined, and some possibly new to science. This collection of Pyralidæ covers the entire group of the Japanese Islands. The botanical collections exhibit strikingly the wonderful affinity between the flora of Japan and that of the United States.

Two incidents are related by the London "Spectator," which seem to indicate that animals are able to think and carry out a plan. They occurred in India. A rough terrier, when given a bone, was sent to eat it on the gravel drive in front of the bungalow. Two crows had sought often to snatch the meat from the dog, but had always been defeated. Finally, they discussed the matter in a neighboring tree; after which one of them flew down and pecked at the dog's tail, and while he was attending to this matter, the other one came and seized the bone. The same dog had a favorite seat, of which a visiting dog had frequently deprived it. One day, the terrier, having found his seat thus occupied, flew savagely out of doors, barking at a supposed enemy. As the intruding dog rushed out to take a part in the fray, the terrier hastened back to secure possession of its seat.

President Willits, of the Agricultural College of Michigan, while he disputes the exercise of a direct influence of forests in promoting moisture—saying that all the trees in the world will not put it where it is not—believes that the moisture on the continent is advancing toward the west, and that the planting of forests and increased cultivation will cause the rainfall to advance farther west every year. Seven hundred thousand acres of forest have already been planted in Nebraska; the cotton-wood and the willow first, and then the soft maple and the hard woods.

Two skeletons of Akkas, from central Africa, representing probably the smallest of the human races, have been received at the British Museum from Emin Pasha. As described by Prof. Flower, though both of full-grown people, they are hardly four feet high, while a woman of the race, measured by Emin Pasha, was still shorter. They are well formed, and present most of the characteristics of the negro race, except that the skull is rather rounder than usual. They appear to belong to the branch of the human race called "negrito," which includes also the smaller tribes of the Indian Archipelago.

The north side of the Romsdal, Norway, is a magnificent wall of dark-colored rock, ranging at the lower part of the valley from two to three thousand feet in height. Over this are poured a multitude of cascades, some of them mere threads of water. On a clear summer's day the continuous sunshine warms the dark rock so effectually that some of these minor falls, after breaking, as they all do, into snow-like spray, vanish altogether by evaporation.

Austria, according to a British consular report from Trieste, has a larger proportion of forest to its area than any other country. The woods cover about 3,500,000 acres, of which 80 per cent is timber forest, and the remainder is of young growth. The Government and the large land-owners own 69 per cent of the whole, the parish authorities 20 per cent, the clergy 5½ per cent, and the peasants about 1½ per cent. The total value is estimated at $200,000,000, and the annual increase at $2,500,000.

According to the British consul at La Rochelle, since the failure of the vineyards from phylloxera, an imitation of claret is made there by steeping raisins and currants in water and mixing the compound with cheap Spanish wine. In other districts of France, a spurious brandy is made from a mixture of beet-root and cheap German spirit. This, having been sent to a port of exportation in its true character, is re-marked and sent abroad as cognac.

Why, asks Prof. W. Mattieu Williams, must we suppose the existence of a luminiferous ether distinct from other matter, when it is just as easy to account for the phenomena of heat, light, electricity, magnetism, and chemical force as "modes of activity of ordinary matter, analogous to the waves of sound," but differing from them by being molecular vibrations, while sound is molar vibration? Gaseous matter being infinitely expansible in the presence of radiant heat, there is no difficulty in imagining space filled with ordinary gases thus expanded, and performing all the functions ascribed to the ether.

In a paper on "Earthquake-Sounds," Prof. Milne suggests that there is a close connection between the sounds that precede the shock and the smaller vibrations that bear a like relation to them. He had counted as many as seven per second of these sinuosities, and believes that we are warranted in assuming the existence of still smaller and quicker vibrations preceding even these. With more delicate seismographs we might be able to catch the very early infinitesimal movements that herald the approach of an earthquake. With thirty or forty vibrations per second, we should have an audible note of very low pitch.

THE sum required to secure the erection of the monument to the chemist Scheele at Köping, Sweden, has been collected.

OBITUARY NOTES.

EPHRAIM GEORGE SQUIER, a distinguished American archæologist and author, died in Brooklyn, N. Y., April 17th. He was one of the first persons, in conjunction with Dr. Edward H. Davis, of Ohio, to undertake a systematic exploration of the ancient mounds and earthworks of the Mississippi Valley, and their joint account of their explorations, published by the Smithsonian Institution, is still the fullest work, and a standard for reference on the subject. He also published a memoir on the Aboriginal Monuments of the State of New York"; accounts of researches among the ruins of Central America and Peru; a "Monograph of Aboriginal authors who have written on the Aboriginal Languages of Central America"; and "Tropical Fibers and their Economic Extraction." He was in his sixty-seventh year. The death of Mr. Squier was followed, on the 15th of May, by that of Dr. Davis, his coadjutor in the preparation of the "Ancient Monuments of the Mississippi Valley," in the seventy-eighth year of his age. Dr. Davis began to explore mounds while a student in Kenyon College, Ohio, and presented papers on the results of his work as society and college exercises. He was encouraged to continue his explorations by Daniel Webster. He opened nearly two hundred mounds in the Mississippi Valley at his own expense, and gathered a large collection of relics, which are now in Blackmore's Museum, at Salisbury, England. He became, in 1850, Professor of Materia Medica and Therapeutics in the New York Medical College.

DR. EMIL BESSELS, the physician and scientific leader of the Polaris Expedition, died in Stuttgart, Germany, March 30th, aged forty years. He was a native of Heidelberg, and first became known through an expedition into the Spitzbergen Sea. In 1871 he took the scientific direction of the Polaris expedition. He was afterward appointed a secretary to the Smithsonian Institution. He was the author of "Scientific Results of the United States Arctic Expedition," "Physical Observations" of the same, a German account of the expedition, and of contributions in American and German scientific journals.

PROF. LEONE LEVI, an eminent English statistician, has recently died at his home in London. He was born in Ancona, Italy, of Hebrew parents, in 1821, and came to England when twenty years old. He originated the movement for the establishment of the Chamber of Commerce in Liverpool, the oldest of institutions of that class. Having lectured for some time in King's College on commerce, he was made professor of that branch. The London "Daily News" characterizes as the three directions in which his work has perhaps been of most public value as being in his exposure of the evils of war, his minute and careful investigation of questions bearing on the wages of the working-classes, and his conclusive dealing with the fair-trade folly in connection with the depression of trade.

PROF. ALEXANDER DICKSON, of the University of Edinburgh, who died at the close of 1887, was a botanist most distinguished for his investigations of the morphology of several of the conifers, and on the diplostemony of the flowers of the angiosperms; for various contributions to the study of the embryology of flowering plants; for researches on the development of the pitcher-plants; and for various special studies.

DR. GERHARD VON RATH, the eminent German mineralogist, died in Coblentz, April 23d, while on his way to the East on a scientific expedition. He was born in 1830, was appointed a professor at Bonn in 1863, and became recognized as the most distinguished representative of mineralogical science in Germany.

THE death is reported of Surgeon-Major F. S. B. François de Chaumont, F. R. S., Professor of Military Hygiene at the Army Medical School, Netley, England. He was fifty-five years of age.

VICE-ADMIRAL THOMAS A. B. SPRATT, of the British Navy, who has recently died, made many most valuable contributions to geography during his thirty-six years of continuous service in Mediterranean stations, in connection with which he made many surveys and explorations. His chief publications concern these surveys; and his deep soundings and dredgings have been commended as having been essential to the elaboration of Edward Forbes's views on the submarine zones inhabited by different classes of animals.

NICHOLAS VON MIKLUCHO-MACLAY, one of the earliest and most industrious of the explorers of New Guinea, has recently died, at the age of forty-two years. He was the son of a Russian nobleman, and, having studied medicine and natural science at St. Petersburg and the Dutch universities, visited Madeira with Prof. Haeckel, in 1866, and afterward the Canary Islands and Morocco. He spent a year in 1871–'72 in exploring the northwest and southwest coasts of New Guinea; then visited Farther India, Malacca, and various island groups; and, in 1876–'78, explored the northern coast of New Guinea. He visited this island again in 1879, and returned to Russia in 1882 with rich collections. He resided for some time in Sydney, and founded a biological station there.

SPENCER FULLERTON BAIRD.

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THE OCTROI AT ISSOIRE: A CITY MADE RICH BY TAXATION.

By DAVID STARR JORDAN,

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IF you look on a good map of France, you will find, a little south of the center, a small, squarish area, painted red, and bearing the name of Puy-de-Dôme. This Puy-de-Dôme is a strange region, made up of fertile valleys separated from each other by ragged hills which were once volcanoes in Palæozoic times. These volcanoes have long since retired from active life, and are black and dismal now, their faces scored by lava-furrows, like gigantic tear-stains dried on their rugged cheeks. In their craters are ponds of black water full of perch and trout—as black as the rocks above which they swim. The highest of these hills the people call the Puy-de-Dôme—the Cathedral-peak. There is an observatory on the top of it, and all the country that you can see from the mountain-summit makes up the "department" of Puy-de-Dôme.

On the south side of the department, near what one might call the "county line," you will find, if your map is a good one, the little city of Issoire. Issoire is a very old town. The Romans knew it. They found it when they invaded Gaul, 1900 years ago, and they called it Iciodorum. They found it again in the year 287, when they came up to convert the Gauls to Christianity, a thing which they had neglected to do upon their first visit. The Romans brought with them a pious monk, St. Austremoine by name, and the people of Iciodorum captured him, and he was duly roasted in accordance with their heathenish customs. So, as the blood of the martyrs is the seed of the Church, Issoire came in

time to be famous as having the largest church and the best parish schools in the whole province of Auvergne.

Issoire has a long, long history, which is duly set forth in Joanne's "Guide-Book," but which I have luckily forgotten. Its story is one of castles and robbers and chivalry, with here and there a fair dame and an ancestral ghost, perhaps, but of this I am not so certain. Once Issoire fell into the hands of the famous knight, Pierre Diablenoir, the Duke of Alençon. After plundering all the shops, burning the houses, killing most of the people, and scaring the rest off into the woods, he set up in the public square a large column bearing this simple legend: "Ici fut Issoire!" ("Here was Issoire"). Were it not for this touching forethought, we might be to this day as ignorant of Issoire's location as we are of the site of Troy.

But the years went on, the wars were ended, the rain fell, the birds sang, the grass grew, the people came back, and Issoire arose from its ashes. To-day it is as dull and cozy a town as you will find in all France. It has now, according to Joanne, a population of 6,303 souls, and a considerable trade in grain, shoes, millstones, brandy, and vinegar. The streets of Issoire are narrow, and the houses are crowded closely together, as if struggling to get as near as possible to the church for protection. The city lies in the fertile valley of the little river Couze, surrounded by grain-lands and meadows. Toward the north a long white highway, shaded by poplars, leads out across the meadows and hills toward the larger city of Clermont-Ferrand, the capital of the department of the Puy-de-Dôme. Issoire is inclosed by an old wall, and, where the highway enters the town, it passes through a ponderous gate, which is always closed at night, as if to ward off an attack from some other Duke of Alençon.

I strolled out one midsummer afternoon on the road leading to Clermont. When I came to the city gate I first made the acquaintance of the *octroi*. A little house stands by the side of the gate, and here two or three gendarmes—old soldiers dressed in red coats with blue facings—watch over the industries of the town. Wheelbarrow loads of turnips, baskets of onions or artichokes, wagon-loads of hay, all these come through the city gate, and each pays its toll into the city treasury. One cent is collected for every five cabbage-heads, or ten onions, or twelve turnips, or eight apples, or three bunches of artichokes, and other things pay in proportion. This payment of money is called the octroi. The process of its collection interested me so that I gave up all idea of a tramp across the fields, sat down on an empty nail-keg, and devoted myself to the study of the octroi.

The octroi is an instrument to advance the prosperity of a town by preventing the people from sending their money away.

It is a well-known fact that individuals become poor simply because they spend their money. So with cities. What is true of the individual is doubly true of the community, itself but an aggregation of individuals. Nations, as well as individuals, grow rich by doing their own work. Commerce, as is well known, is a great drain on the resources of a town as of a nation. Now, if in some way we can keep the money of a town within its limits, the town can not fail to grow rich. As Benjamin Franklin once observed, "A penny saved is twopence earned." The great problem in municipal economics is this: How shall we keep the town's money from going out of it? How shall we best discourage buying—especially the buying of articles from dealers outside?

To meet this problem, the wisdom of the fathers devised the octroi.

In view of the prospective introduction of the octroi into America (and I trust that I am violating no confidence in saying that this is the real object of the present visit to Europe on the part of one of America's foremost statesmen), it is worth while to examine carefully its nature and advantages.

Years ago, before the octroi came to Issoire, the city was noted chiefly for the barter of farm products. The farmers used to bring in grains, hides, cheese, and other produce, which they would exchange for clothing, sugar, coffee, tobacco, and the various necessaries of existence. The merchants used to load the grain into wagons which were driven across the country to the city of Clermont. Here the grain was exchanged for clothing, food, and all manner of necessaries and luxuries which were made in Clermont, or which had been brought thither from the great city of Lyons. There were long processions of these wagons, and all through the autumn and winter they went in and out. And the Issoire people were very proud of them, for neither coming nor going were they empty, and the teamsters of Issoire were the most skillful in the whole basin of the Loire.

But the mayor of the city and other thoughtful people saw cause for shame rather than for pride in the condition of Issoire's industries. It was ruinous thus steadily to carry away the wealth of the land and to exchange it for perishable articles. When a wagon-load of boots, for example, had been all worn out, then the boots were gone. The money that had been paid for them was gone, and, so far as Issoire was concerned, it was as much lost as if money and boots had been sunk in the bottom of the sea. The money that was *paid out*, I say. Not so with the money that was *paid in*. If those boots had been bought in Issoire, the money that they cost would still be in town, still be in circulation, and would go from one to another in the way that money is meant to go. This drain must be stopped, and the octroi could stop it. So

it was enacted by the Common Council of Issoire that "whosoever brings a pair of new boots into Issoire shall be compelled to pay ten francs," which was the cost of a pair of boots at Clermont. The purpose of this order was not to raise money, but to have boots made at Issoire, that the wearing out of these necessary articles should not wear out, at the same time, the wealth of the town.

"People will have boots," the mayor said; "they can not afford to bring them in from Clermont, and so they will make them at Issoire, and all the boot-money will remain at home. It is as though, so far as the city is concerned, Issoire gets her boots for nothing. To be sure, Clermont has a good water-power, and her nearness to the mountains makes the price of hides and tan-bark lower, but this has nothing to do with the question. Natural advantages amount to nothing when artificial advantages can be given by a mere stroke of the pen. The laws of political economy are not of universal application. Depend upon the octroi to make all things equal."

A new boot-factory was now built at Issoire, and boots were offered for sale at twenty francs a pair. The cost of boots at Clermont was ten francs, and the octroi charges at the city gate amounted to ten francs more. Buying at twenty francs would save the purchaser a trip to Clermont and back, and, as trade is apt to flow in the direction of least resistance, after a little the Issoire boot industry became fairly established. There was some grumbling at high prices. Some of the laboring classes went barefooted, while the doctor and the schoolmaster put their children into wooden shoes, or sabots, such as peasant children wear. But the mayor and the Common Council took shares in the new factory, and, being members of the company, they got their boots at the old rate, besides having a part in the large dividends which the business soon began to yield. Employment was given to more workmen, who came over from Clermont; the hum of machinery took the place of the creaking of farm-wagons, the rich began to grow richer, the poor went barefooted, and the people of moderate means felt able to run into debt because they lived in a progressive town. The wives of the members of the Common Council bought diamonds, and the members presented the mayor with a gold-headed cane. Soon other boot-factories were started, and still others, though, strangely enough, the more boots were produced, the more barefooted children were seen in the streets.

By and by the tanners decided that they too must ask for help from the octroi. It was as bad, they said, for the factories to send to Clermont for leather as for the merchants to send for boots. In either case, the money went out of the town, and was gone forever. So the octroi was levied on leather as well as on boots.

Then the guild of butchers put in similar claims. To buy raw hides of the herdsmen out on the Puy-de-Dôme was a part of the same suicidal policy. The octroi was therefore assessed on all imported skins. The butchers established their own stock-yards within the city walls, and were saved from the pauper competition of the mountain cattle. Then the mountain herdsmen drove the cattle on to Clermont, and Issoire was left in peace.

But some of the boot-makers complained that this policy was injuring their business by greatly raising the price of hides, whether produced in Issoire or at Clermont. So the mayor sent a letter to the Issoire "Gazette," a long letter which the schoolmaster had helped him to compose, and in which he showed conclusively that the purpose of the octroi was to make things, not dearer, but cheaper. Said he: "The ultimate result of the octroi is always in the end to reduce prices. The sole purpose of the octroi on hides, for example, is to educate our people in the art, so to speak, of raising hides. By this education, they may, by superior intelligence, experience in the business, and the acquirement of knowledge on the subject, be enabled to produce cowhides in such abundance, by new and improved methods, that they may sell them much cheaper than they do now, sell more of them, and yet realize a larger profit on each hide than they can do at present. If there is a fair prospect that this can be accomplished, who shall say that it is not a part of wise statesmanship to attempt this result? Cattle-raising is now carried on in the most primitive way, by driving the cattle about as though they were wild beasts from place to place on remote and uninhabited hills. The octroi will tend to encourage each householder in Issoire to keep his own cow, produce his own leather, thus diversifying his business and giving him some new product to sell every year, some new demand for labor."

And the thoughtful men of Issoire, the leaders of public opinion, saw the force of this argument, and they were satisfied to submit to temporary inconvenience for the sake of the industrial education of the people.

But the boot-trade was already growing slack. The market had supplied boots for all, but the people perversely refused to take them. The shop-windows were full of boots, temptingly displayed in rows of assorted sizes; nevertheless, every person in Issoire, except those engaged in boot-making, seemed bent on wearing his last year's boots rather than pay twenty francs for a new pair. The high price of leather and hides since the exclusion of the mountain cattle began to reduce the profits in boot-making, and so some of the factories threw a poorer article on the market, without, however, any corresponding reduction in price. And people found that it was cheaper to go to Clermont again

for boots, notwithstanding the payment of the octroi. Accordingly, the old wagons were sent out once in a while, by people who had more cupidity than patriotism. And a little coterie of aristocrats who sneered at the mayor as a demagogue, and at the octroi as a "relic of the middle ages," used to wear Clermont-made boots, and to ape Clermont fashions. But all good citizens discouraged this, and the maintenance of the "Issoire idea" became one of their articles of faith, next to those in the catechism.

But Clermont-made boots often came in on the sly—no one knew how—to the dismay of the local dealers. The Common Council saw that this would not do, and that the single old soldier who guarded each of the city gates could not meet all the requirements of the octroi. So at each gate were placed a dozen gendarmes, in red woolen uniforms, with black caps fastened on by a leather band which went around the lower lip. And the gendarmes searched every cart and every ash-barrel that went in or out. They watched every rat-hole in the wall to see if haply, by day or by night, boots should come into Issoire without the chalk-mark of the octroi. Occasionally some poor wretch was taken in the act of throwing boots over the wall, and made to pay the penalty of his crime. But sometimes even the gendarmes themselves, the guardians of the prosperity of the community, were seen walking about in Clermont-made boots, which they had obtained by a process known as "addition, division, and silence." The mayor noticed this one day, but the gendarmes had just presented him with a gold-headed cane. They were very much devoted to the Issoire idea—it was just before election—and on the whole he thought it best to say nothing about it.

The problem now before the mayor and the Common Council was this: How shall we put life into the boot-trade? The stock was large, its quality was excellent, and yet for days at a time the boot-shops would not see a customer. Something must be done. At last, an ordinance was passed that every citizen of Issoire must have at least one new pair of Issoire-made boots, which must be worn on Sunday afternoons when the band played in the park—at which time the gendarmes would go about on a tour of inspection. When Sunday came, half the workingmen stayed at home all day, because they had not the money to meet the requirements of the law.

But a few of the bolder ones went to the mayor and said openly: "If you want us to wear Issoire-made boots, you must furnish them for us. You ought to do it anyhow. This city owes us a living, and we came over here from Clermont to get it. We were told that the workingman in Issoire would have the octroi on his side, and would not have to work like a slave to keep soul and body together, as we had to do at Clermont. But it is the same

old story here. We do all the work, and somebody else gets all the profits. Now we have to buy and pay for the boots we make ourselves. The cowhide in a pair of boots costs the capitalists but a franc, and we, the boot-makers, pay twenty francs for the boots when we have made them. The other nineteen francs are the product of labor, and ought to belong to us. Our boots should be furnished at a franc a pair."

So they held a mass-meeting in the *café* of the Lion d'Or, and resolved that the rights of man were not respected in Issoire. They sent a delegation to the mayor, asking that boots for the workingman be furnished at the expense of the town. This would be but justice, and, moreover, it was the only way to start anew the wheels of industry. Money should not be locked up in the city treasury. It should go from man to man, and this action was sure to set it going.

Then the schoolmaster wrote a long letter to the Issoire "Gazette," and showed very clearly that this claim was on the whole a just one. Nobody understood the argument, but all applauded it because it looked very learned; and, moreover, its conclusions were in harmony with their previous opinions. The schoolmaster showed that, as boots were worth twenty francs a pair, and the leather in them cost but one franc, the nineteen francs left were the product of labor, and should rightfully be returned to the laborer. Now, in Clermont, where boots were made by pauper labor, the boots sold for ten francs, and the leather in each pair was worth but fifty centimes. In Clermont, therefore, the rightful share of labor, even if labor had its due, which it never has in this world, was only nine and a half francs; that is, to labor belonged nine and a half francs on each pair of boots in Clermont, and nineteen francs in Issoire. The lot of the laborer was therefore twice as delightful in Issoire as in Clermont, this difference being due to the beneficent influence of the octroi.

And the Common Council, who were friends of labor, decided that hereafter the price of boots should be twenty francs to workingmen, but that nineteen francs of this should be paid as a bounty from the public treasury. But, "always taking out of a meal-bag and never putting in, soon comes to the bottom," as Benjamin Franklin once said, and there have been few shrewder observers of French politics than he. One morning, when the treasurer put his hand in the strong box to get the nineteen francs to pay for one more pair of boots, he found it empty. There were only a bad franc, a fifty-centime note, and half a dozen copper sous and two-centime pieces; nothing more. He had come to the bottom.

Here was a crisis! The mayor and the Common Council were called together in haste. The workman, Jacques, who wanted the

boots, was waiting outside, a big, burly fellow, with a sledge-hammer fist and an unpleasant look in his eye. The mayor took one glance at him, and saw that he was not to be trifled with. Moreover, this one case was not to end the difficulty. The road to Clermont and the road across the mountains to Aurillac, the chief town of the next department, Cantal, were black with the advancing hosts of workmen coming to share the privileges which Issoire held out to the oppressed of every city. Through the windows of the Hôtel de Ville the mayor could see them coming, and he knew that the demand of each one of them would be "boots." It was not one pair of boots to be paid for, it was a thousand! There were boots enough in Issoire. The factories were never so prosperous, and the money they received from the city was kept in rapid circulation. The grocers got some, the butchers some, a good deal went to the landlady of the Golden Lion, and the wives of the factory-owners and the councilmen bought diamond necklaces and bracelets to match the ear-rings which they had before.

But this could not go on unless the city treasury could meet the demands upon it. In the words of a celebrated economist, "The mill can never grind again with the water that is past," and, unless new water could be procured, grinding was over at Issoire. The town must have money, or else the factories would be closed, the supply of boots cease, and each citizen of Issoire would have to keep the wolf from the door by his own unaided exertions.

It was a great crisis, but such crises, "God's stern winnowers," as the poet calls them, are the making of great men. And this crisis made a great man of the mayor of Issoire, or rather it made a background against which his greatness could be seen. I have forgotten the mayor's name, and I am very sorry for it. It was a French name and wholly unpronounceable to me, something like De Rougeâtre, or De Rousselieu; but if ever the name of a mayor were

"On Fame's eternal beadroll worthy to be filed,"

it is his, and it is my constant regret that I can not file it there.

And the mayor said: "All our prosperity is due to the action of the octroi on a single article of necessity—namely, boots. This is prosperity along a single line only, a one-sided development of our industries, and from this comes our present embarrassment. Put the octroi on everything, and you have prosperity along the whole line. Some of these things we can produce at home, some we can not. Those that we can not produce the people will have somehow, and from these you can raise the money to pay for the boots which Issoire recognizes as the just due of the toiling workingman." Here the mayor wiped a tear from his eye, and raised his voice a little, in the hope that perchance some toiling workingman might be listening outside, or taking his needful midday rest at the Golden Lion, next door.

"On the tea, coffee, pepper, brass, tin, diamonds" (here the Common Council heaved a sigh), "and other articles which Issoire can not produce, we will raise the income which the city needs. And the great charm of this tax is, that the people will not feel it at all, for it will all be paid by outsiders, by these merchants from Clermont and Lyons who send their goods to our town. They own the goods, they bring them here, they pay the octroi, for we need not buy of them until the goods are safe inside the city gates. By a single stroke in financial policy, we shall keep our factories running, our workingmen contented, and make the merchants in our rival cities pay all our expenses. As for the other articles which we buy in Clermont, we can make them here, if only we can have the octroi to help us. Extend the octroi to everything, and Issoire will become a microcosm, a little world within a world. We shall do everything for ourselves. There is no excuse for buying anything in Clermont so long as there is a foot of land in Issoire on which a factory can be built. We shall have woolen-factories, and powder-factories, and iron-foundries, and distilleries, and cotton-factories, and wine-vaults, and chair-factories, and stone-quarries, and gold-mines, and flouring-mills, and paper-mills, and saw-mills, and wind-mills, and gin-mills, and—"

But here the mayor began to grow a little incoherent. He had been out late the night before, explaining the advantages of the octroi at the club in the Café de la Comédie, and his private secretary pulled his coat in warning that he should bring his speech to a close.

The mayor's recommendation was accepted in part. A few of the Council had been in favor of issuing some kind of cheap money—some sort of brass or paper token, which they could make by machinery whenever the treasury became empty. But the majority had seen this kind of money before, and they firmly resisted the suggestion. By way of compromise, they agreed to extend the octroi to twenty-seven articles—mostly articles of food or clothing which had been brought in from Clermont or from the mountains of the Puy-de-Dôme. The workman Jacques was dismissed with a pair of boots, for which the mayor himself paid. Jacques left the council-chamber satisfied, and the crisis was averted.

And now money flowed in again to Issoire. The farmers who brought in onions paid a little, the boy who pulled water-cresses a little, the milkmen a little, the vine-growers a good deal more, but most of all came in from the merchants of Clermont, who in spite of all discouragement still persisted in carrying cheap goods to Issoire.

Prices went up; a sure index of prosperity. It was easy to pay one's debts—easier still to make new ones; but the great thing was

that the money was kept in town. To go from hand to hand, from hand to hand, and then from hand to hand again, as in the endless round of the fairy tale—that is what money is for. Factories sprang up as if by magic, and down the long white highways multitudes of the crushed and down-trodden of other cities were seen tramping along to share the prosperity of Issoire. Five hundred soldiers in red and blue uniforms had taken the place of the dozen gendarmes, the dome of the church was gilded anew, and the poet wrote a sonnet in which Issoire was compared to the island of Calypso, and the mayor to Ulysses.

But the weather was never so pleasant that nobody had the rheumatism. Never was country so happy that the grumblers all kept still. There were some complainers even at Issoire. Those who lived on incomes and endowments said that with the rise of prices it was every day harder to make both ends meet. One wealthy man who wore Clermont-made boots, and had furnished his sons with private tutors, and saddle-horses and gold watches, now found it almost beyond his means to keep them in ordinary clothing. But he soon removed to Clermont, and others of the same sort went with him. With them, too, went the widows and orphans who lived on endowments, and the old soldiers who had government pensions.

But the mayor said: "Let them go; it is a good riddance. They belong to the non-producing class, a class that hangs like a millstone on the neck of labor."

But, in spite of all adverse influences, many people from Issoire visited Clermont in fine weather for pleasure or for trade. It was pleasant to wander about the larger town, the home of their ancestors, to be a part in the bustle of its streets, and to breathe its metropolitan air. There were better opera-houses there and picture-galleries, and there was a special charm in the shops where prices far below those at Issoire were ostentatiously fixed on elaborately displayed wares. And so—almost before the owner knew it—many an Issoire wagon was loaded down with cheap goods from Clermont. But, although the octroi was paid at the city gates, the real purpose of the octroi was evaded. The money, in the first place, was spent outside the city. Worse than this, the octroi, instead of being paid by the agents of the Clermont merchants—as the law intended—was collected, as the mayor of Issoire now said, "off our own people." For, if the octroi is to be collected in this way, "off our own people," it would be just as easy and a good deal cheaper and fairer to collect the tax in the usual way, in direct proportion to the value of each man's income or capital.

Another ordinance was clearly necessary. The wagon-maker at Issoire had long since gone out of the business. The prices of

wood, iron, leather, and paint were such that he could not compete with Clermont manufacturers. So the wagon-shop was closed, and carriages and vehicles of every description were brought over from Clermont. The cost of these vehicles had been a heavy drain upon the resources of Issoire. The octroi alone would not remedy this, for nothing short of absolute prohibition of outside purchase would revive the wagon-trade. So the mayor proposed that by another bold stroke the dying industry should be revived, while at the same time the citizens of Issoire should be prevented from paying the octroi. It was enacted that no citizen of Issoire should own any sort of vehicle—wheelbarrow, cart, wagon, barouche, carriage, or droschke—unless said vehicle was made in all its parts at Issoire, and bore the signature of the mayor and the seal of the Common Council. This saved the city many thousands of francs, for, now that the people no longer drove over to Clermont, the Clermont merchants sent goods to Issoire; and, when they entered the gates, the Clermont people paid the charges of the octroi.

When the first Issoire wagon was finished, the maker had put such a high price upon it that no one would buy, and the reviving industry began to faint again. The wagon-maker said that he couldn't help it. Unless he could in some way get wood and nails at special prices his wagons would be out of the reach of all buyers. A few of the Common Council were in favor of releasing the wagon-maker from the octroi on articles used in the manufacture of wagons, but the rest were unwilling to do this—because to buy these materials outside is another drain on the prosperity of a town. At last they arranged a compromise, by which the city gave an order for a new street-sprinkler and twelve rubbish-carts, to be paid for from the public treasury. They had no need for a new sprinkler then, and five rubbish-carts would have been enough. But a liberal order like this made the wagon-maker contented, and a generous policy was necessary to start anew the wheels of trade, which, in spite of all their care, were frequently becoming clogged.

Once more the treasury was nearly empty. The citizens of Issoire, accustomed to having their taxes paid by the people of Clermont and Lyons, would not submit to any form of direct taxation. Had the Common Council said: "We must have so much money; we propose to take it from your pockets by a *pro rata* assessment," the people would have risen as one man and put the opposition candidates into office. Direct taxation is a confession of barrenness in expedients. Where money is to be raised, it should always be collected from foreigners, if possible. This is a maxim in political science, and all successful financiers from Julius Cæsar down have acted in accordance with it.

The falling off in the Clermont trade, due to the new wagon

law, had made a serious reduction of the revenue. And now appeared the wisdom of the mayor's original suggestion. What Issoire needed was prosperity along the whole line. A partial octroi means only partial prosperity. A universal octroi insures prosperity which is unbounded and universal.

And so the schoolmaster took a copy of Littré's "Unabridged Dictionary" and the "Dictionary of the Academy," and from these he drew up a list of three thousand eight hundred and seventy-two articles on which the city government might levy the octroi. And the mayor and the City Council sat up half the night to decide just how much octroi each one of these articles should bear, in order to secure the best results to the community.

The list began:

Absinthe	octroi	one franc per bottle.
Accoutrements	"	five francs per set.
Acids	"	one franc per litre.
Alcohol	"	five francs per litre.
Alligators	"	five francs each.
Animals (not otherwise specified)	"	ten centimes per kilogramme.
Arnica	"	five centimes per kilogramme.
Artichokes	"	five centimes each.

And so on, down to zinc and zoöphytes.

The general effect of this law was like that of a refreshing rain upon a thirsty field. Everybody took heart, and general confidence in the future is the chief element in financial prosperity. But the law had some curious results.

The octroi on elephants was so high as to be prohibitory, and the Italian organ-grinder thanked his stars that he and his monkey were well inside the city gates before the law went into effect. The combined tax on quadrumana and musical instruments was more than he could pay. Once within, however, he enjoyed a full monopoly, and this, so the schoolmaster told him, was just what the law originally intended, for octroi is spelled in Latin "auctoritas," "by authority," an authorized monopoly. The manufacturers of dolls were much encouraged. Christmas was coming on; the children must have dolls; and the pauper doll-makers of Jonas, with whom Saint Nicholas had been in the habit of trading, were by no means able to pay the octroi.

But, on the other hand, the trade in looking-glasses was nearly ruined. The octroi on glass, quicksilver, wood, tin, varnish, and glue, drove the mirror-maker distracted. The people took to polishing up tin pans, and to looking into dark windows or down into deep wells, in search for the truth that is metaphorically said to be lying there. Then the law offered some curious anomalies. For instance, a sheep with the wool on went through the city gates for fifteen francs. If the wool was taken off, it was charged

a franc per pound, and the sheep went in as mutton, paying five francs. It was, therefore, cheaper to take a sheep to pieces outside of the city gate rather than within.

Again, there was a curious complication in the matter of boot-jacks, a humble article of domestic use, manufactured in the little village of Jonas, just mentioned. If these were sent in as household furniture, each paid a franc, while, as wooden-ware, the charge was fifty centimes.

With the millstone-trade the results were even more remarkable. One of the chief articles of export from Issoire, in its early days, was the stone used in flouring-mills. In the lower part of the city, close to the river Couze, there is an extensive quarry of a coarse, hard sandstone, most excellent for milling purposes. It had long been a saying with Issoire people, "We send Clermont the wheat, and the stones to grind it." The Issoire millstones were not inferior to those quarried in Cantal, and, the distance from Clermont being much less, the Issoire millstone-cutters had almost a monopoly of the Clermont trade.

In the early days of the octroi, however, the wagons which had formerly brought over manufactured goods in exchange for millstones were obliged to go to Issoire empty. Thus their owners had to charge for one trip almost the former price of two. This increased cost of transportation brought down the price of millstones in Issoire, for the competition of the quarries of Cantal made it impossible to raise the price at Clermont. To do that would be to divert the trade of the Clermont mill-owners entirely to Cantal. In such cases, the prices for the whole region must be governed by the price at the center of trade. The profits of the Issoire quarry were thus materially reduced. The owners talked of reducing the wages of their employés, but this they could not do, for the wages were already at the lowest point at which effective service could be secured. The natural remedy lay in an appeal to the octroi. The Council levied five centimes per kilogramme on all millstones brought into Issoire. Some of the Council thought this levy an absurdity, for not a single millstone had ever been imported. The old proverb as to "carrying coals to Newcastle" was intended to cover just such cases. But the mayor told them to wait and see, and the result showed his far-seeing wisdom. The quarry-owners doubled their home prices, while the octroi preserved them from loss through outside competition. Then followed one of those curious surprises which lend such zest to the study of French economic problems. The price of millstones at the quarry in Issoire was nearly double the price of the same millstones in Clermont, whither they were carried by salesmen from Issoire. After a time Issoire mill-owners began to send to Clermont for millstones, instead of buying them at home. It was

cheaper for them to buy their home products in another city, to pay carriage both ways, and to pay the octroi at the city gates, than it was to send across the street in Issoire for the same article. Freedom from competition at Issoire enabled the quarry-owners to fix their own prices at home, and thus to broaden the slender margin of profits which came from outside trade. This peculiar condition reached its climax when one of Beltran's wagons from Clermont left Issoire with a load of millstones, while, next day, the same wagon, without unloading, carried the same millstones back to be used in the mills of the Issoire General Company of Flour and Meal! The schoolmaster was ecstatic over the stimulus thus given to several industries at once. It was like killing many birds with one stone. But the Issoire Association for the Home Production of Millstones was not satisfied with Clermont competition, even in this peculiar form, and an increase in the octroi soon put further importations out of the question.

There were also some curious omissions in the list, in spite of its length and complexity. An old woman, Widow Besoin, who lived near the Cantal gate, had five speckled Dominick hens, of which she was very fond. These hens were to her a source of profit as well as pleasure. She came to the mayor with the complaint that her neighbor, Farmer Bois-rouge, who lived just outside the city gate, brought in the eggs of his chickens free, and sold them at prices far below those she was compelled to charge for the eggs of her hens. The Bois-rouge chickens roamed over the whole farm and lived on grasshoppers and gleanings, while hers were fed on grain which had passed the octroi. It seems that the schoolmaster, in making up the octroi list, in arranging the o's had neglected to look for words beginning with "oe," and so had omitted the word "œuf," which is the French for "egg." So the Council was called together, a rate for "œufs" was agreed upon, and Widow Besoin's Dominick hens were free from the pauper competition of the chickens of Farmer Bois-rouge.

But the action of the octroi was, on the whole, as I have said, extremely beneficial. It filled the treasury again, and it stimulated a large number of infant industries, which had previously been unable to compete with established industries in surrounding towns, on account of the high prices of raw materials, and especially of labor, at Issoire. It is true that workman Jacques and some of the other laborers complained that these high wages were high in name only. In Clermont, men worked for three francs a day, but these three francs would buy twelve yards of calico or ten pounds of sugar, while the five francs received in Issoire would buy but ten yards of calico or eight pounds of sugar. But the schoolmaster wrote another letter to the "Gazette," showing that the question of wages was solved by an estimate of

what the laborer saved, not by what he could buy with his wages. "Every workingman," said he, "as statistics show, saves thirty per cent of his wages. In Clermont, therefore, the laborer lays up one franc per day, or three hundred francs per year. In Issoire, he lays up one franc fifty per day, or four hundred and fifty francs per year, a difference of one half in favor of the workman at Issoire as compared with the pauper labor of Clermont."

The workman Jacques read this aloud in the bar-room of the Lion d'Or, and pondered over it a good deal, for the logic was irrefutable, and yet after all these years he had not four hundred and fifty francs which he could call his own.

The mayor made a speech to the workingmen, congratulating them on his re-election, and assuring them that "for them and for them alone the octroi was brought to Issoire. It was the pride of Issoire that its workingmen were princes and not paupers. If they paid high prices for articles of necessity, it was only that they might get higher prices in return. You sell more than you buy, and what you sell, the strength of your own right arms, costs you nothing, and, when it is sold, is as much yours as it was before. It is God's bounty to the workingman. If these industries which the octroi has built up around you are left unprotected, you too would be left without defense. In the natural competition of trade, the rich grow richer and the poor poorer. Without the octroi we should behold here as at Clermont the spectacle of the chariot-wheels of Dives throwing dust into the eyes of Lazarus. But here in Issoire, Lazarus is, so to speak, already in Abraham's bosom. The workingmen of Issoire have no truer friend than Issoire's mayor, and to cherish their interests is the dream by day and by night of Issoire's Common Council."

But we must return to the boot-trade, on which the octroi was first established. The history of that industry is the history of all the others, for in one way or another all experienced the same changes and conditions.

The profits were large at first, and very soon the Issoire Citizens' Foot-wear Manufacturing Association had no longer a monopoly in boots and shoes. The original concern still retained the city contract for supplying boots to the laboring-men, but the others found the general trade no less profitable.

But soon an unexpected decline in boot consumption took place. People perversely wore their old boots, which had long passed the season of presentability. The children went barefooted or shuffled around in sabots. Even worse, many parents bought for their children a new kind of copper-toed shoe, which was made in Clermont—a shoe that could never wear out at all; one of the worst possible things for the shoe-trade in any country!

When it was found that boots and shoes enough to last for five

years were for sale in the shops, it was evident that something must be done. The original concern decided to wait. It closed its factory and discharged its workmen. But some of the other firms could not wait. They must have their money back or go into bankruptcy. Shoes began to come down. Every shoe-dealer was alarmed, and a meeting was held in the Café de la Comédie to see what could be done. It was decided to lower the prices and then to maintain them. Boots were rated at fifteen francs per pair, and shoes and slippers in proportion. But one dealer could not keep his promise. He had a very large and handsome new shop, and he had spent much money in fitting it up. A gentleman, named Shylock, from whom he had borrowed the money, said that he had lent money for legitimate business, not for speculation; to sell shoes, not to hold them for higher prices. This stock of boots was thus forced on the market, to be sold for what it would bring. And other dealers had to sell for similar prices, or lose all chance of selling at all. And so Issoire was full of notices:

"GRAND SLAUGHTER OF BOOTS AND SHOES!"

"BOOTS GIVEN AWAY—ONLY FIVE FRANCS A PAIR!"

Boots were never so cheap before, in Issoire or anywhere else in France.

The Issoire Citizens' Foot-wear Manufacturing Company took no part in these cheap sales. Its agents were active, however, and they privately bought up a part of the stock of the smaller stores, and sent out several wagon-loads across the country to Clermont, and one down the river to the farmers in the valley of the Loire.

It was an era of cheap boots. Everybody was well shod. The children burned up their wooden shoes, or used them only for coasting in the winter, and there was general satisfaction. The Minister of Public Instruction, who spent a day in Issoire on his way from Marseilles to Paris, had a pair of new boots presented to him, and he showed them at home, as an example of what the octroi could do for a town. "Boots," said he to the Minister of Finance, "are actually cheaper to-day at Issoire than they are at Paris or Lyons. So much has the octroi done for my countrymen." And the mayor sent a message of congratulation, reminding the people that his promises had come true. "The octroi has reduced the price of boots, and has demonstrated the truth of the paradox that the quickest road to low prices is to make prices high." The traders who had gone into bankruptcy left Issoire and were speedily forgotten—except by their creditors, chief of whom was Monsieur Shylock. It did not much matter about them in any event. Their loss was the community's gain. It was not Issoire's fault that they were dealing on borrowed capital and could not stand the strain of reduced prices.

After the period of congratulation was over, the President of the Issoire Citizens' Foot-wear Manufacturing Association called the heads of a few of the rival houses to his office. They agreed together to ask for an increase in the octroi, in view of the depressed condition of the boot-trade, after which they would, in view of the increase of the octroi, raise the price of boots to twenty-five francs. They formed a new association called the Issoire Equitable Confidence Society, the object of which was to prevent the Clermont dealers from flooding the city with cheap boots, a thing which the latter had been steadily on the watch to accomplish. The Equitable Society took special pains to serve Issoire by regulating the price of boots according to the city's real needs. The city had suffered from overproduction. Now, when any firm outside the Equitable Society tried to resume work, the price of boots was suddenly lowered, until the competing dealer would be willing to sell out on favorable terms to some of the society's members. There were a few dealers in Issoire who still brought boots over from Clermont. These were made to understand that their course of action was unpatriotic, and that it was displeasing to the members of the Equitable Society. The office of the octroi was visited by several men who accused one of these dealers of having silk stockings concealed in an invoice of boots from Clermont. All the boxes were opened and each boot examined. Then all were thrown in a pile by the side of the street. The owner gathered them up as well as he could, but the street boys helped him, and before he knew it several boys and several pairs of boots were missing together. And so in a hundred ways the Equitable Society discouraged outside and inside competition, until at last the entire boot-trade fell into its hands.

But the rise in the cost of boots had its effect on the workingmen. Clearly the increase in the price of boots was due to the growth of labor, for the price of hides was no greater than it was before, while the value of hides made up into boots was materially higher. If a day's work was worth five francs before, nine francs was not too much now when labor was so much more valuable to the capitalist.

The big workman Jacques thought this out, and in the *café* of the Lion d'Or he advised the workingmen to march in a body to the President of the Confidence Society to demand their rights. They did so, with the master-workman Jacques at their head. Their demand was nine francs a day, or no more boots in Issoire. The president had expected this. In fact, he had rather hoped for it; and so he had kept a good stock of boots in reserve for such an emergency.

He spoke very kindly to the deputation, patted Jacques softly on the arm, but, in brief, said that the state of the trade would

permit no increase of wages at present. Next day the doors of the factories were closed, and each workman received his pay in full, and his discharge.

For a week the factories were empty and silent. The Confidence Society was not idle, however, for a trusty messenger had been sent at once to the village of Jonas. He offered four francs a day to the Jonas men if they would come over to work in Issoire. Now, Jonas is a queer little town, built all around the brow of an old volcano. I doubt if there is another like it on earth. The top of the hill is made of hard lava, below which is a belt of ashes, very old and packed solid, but as easy to cut as cheese. Long ago the ancient Gauls burrowed into this hill and filled it with their habitations. These appear like gigantic swallows' nests when you look at the hill from below. One of the largest of these houses is used as a church, and its lava walls are rudely frescoed over in imitation of the big church at Issoire. Only very poor people live in Jonas now, people who can not pay much rent, and who do not mind the absence of fire in the winter. And the Jonas men were glad to come over to Issoire for four francs a day, to take up the work which the pampered laborers of Issoire had refused.

The coming of the Jonas men was a great surprise in Issoire, and gave rise to much hard feeling. The workmen who were idle met them with eggs and cabbages, and some of them even carried bricks. But the gendarmes were on the side of the Confidence Society, and they protected the new men from any serious harm. So the mob followed sulkily in the rear, shouting "Rats! rats!" It sounded like "Rah, rah!" for this is the French way of saying "rats."

Winter was now approaching, and the discharged boot-makers of Issoire found their condition daily more and more unpleasant. They had an association among themselves called the "Chevaliers of Industry." The big Jacques was master-workman, and they met in the *café* of the Lion d'Or to discuss matters of common interest. They had a good deal to say of the power of organized labor, the encroachments of capital, and maintained that the value of all things is due solely to the labor which is put upon it. The so-called raw material, land, air, water, grass, cowhide, shoe-pegs, all these are God's bounty to men. No one should arrogate these to himself, and all should be as free as air. All else in value labor has given. Capital, the interloper, has unjustly taken the lion's share, and left a pittance to labor. What capital has thus taken is ours, for we have made it. Then the speaker referred to the snug little capital which the President of the Confidence Society had laid away in his strong-box, and which shone out through his plate-glass windows and made itself felt in every smirk of his self-satisfied face. Another speaker said that the thief of labor was

the worst of all thieves, and for them to despoil him was but to seek restoration of stolen goods. And the schoolmaster said that he who takes for his own the value labor has given is worse than he who robs upon the public highway—for he adds hypocrisy to theft.

Some of them counseled an immediate attack upon the managers of the Confidence Society, but the voice of master-workman Jacques was for some compromise which would restore them to employment. There had been a considerable fund collected by the Chevaliers of Industry in the way of dues and assessments. This fund he had distributed among the unemployed laborers, freely at first, but of late more sparingly. There were many who hoped to live through the winter on this fund, and these spoke in no pleasant terms of the master-workman's stinginess. The fund was nearly gone, and Jacques well knew that, if work was not soon resumed, the order of Chevaliers of Industry would come to a sudden end. Organized labor without money is very soon disorganized.

A few heeded his words of counsel and followed his lead to their homes. But the bolder spirits stiffened their resolve with the wines for which the *café du Lion d'Or* is so justly famous, and started for the residence of the President of the Confidence Society. They roused him from his bed, killed one of the Jonas men whom they found asleep at his door, insisted on an immediate division of his personal property—which he was only too willing to grant—and next morning they found themselves in jail, charged with robbery and murder.

There was again excitement at Issoire. The workingmen held mass-meetings at the Lion d'Or, and passed resolutions of sympathy and defiance. The wives and daughters of the members of the Common Council sent bouquets and baskets of fruit to the prisoners, and the mayor said that he loved them as though they were his own sons. But the law in France is in higher hands than those of the municipality. It is swift and sure. The prisoners were taken to the capital city, Clermont, to be tried. The sympathies of the judge were on the side of capital, and he paid little attention to the plea of organized labor. "If your theory is true," said the judge, "you have no sort of claim on the boots you have demanded from the President of the Equitable Confidence Society. All this labor you talk of is simply the moving of things back and forth. How can this confer value? The real work is done by the cow; and the herdsmen on the mountains, who are her heirs and assigns, are the only persons who have a natural lien on the boots which are made from her hide when she is dead. This claim the herdsmen have assigned to capital, and to capital, therefore, all the boots belong."

It is hard to fight against monopolies. The men were condemned. The black flag was raised in the Golden Lion. A good deal was said, but nothing further was done, by organized labor toward taking possession of its own.

A new election was at hand, and the mayor's party issued a call to the workingmen to rally to his support.

"All who believe in the grandeur and glory of France, in the ten commandments, in the theory that the sun is the real center of the solar system, and in the Issoire idea of a perpetual octroi for the defense and development of home interests and the elevation of home labor, who would reduce city taxes and prevent the accumulation of money not needed for city uses, by the perpetuation and extension of the octroi; who are opposed to all schemes tending to dethrone this policy and to reduce Issoire's laborers to the level of the underpaid and oppressed workers of Clermont and Jonas—are called to join in the re-election of Mayor de Rougeâtre and of his supporters in the Common Council."

The mayor spoke from the steps of the Hôtel de Ville in defense of the octroi, on the success of which agency he justly based his claim for re-election.

He showed how the octroi had changed Issoire from a dull and peaceful agricultural village with few industries, and those only the ones for which the town possessed special advantages, into a microcosm in which a little of everything was made and sold. Issoire was no longer a town where nothing happened, and in which the procession of grain-wagons, the same yesterday, to-day, and to-morrow, wearied the eye and the ear with their ceaseless monotony. It was a city in which the clashing of interests and the fluctuation of prices made every one anxious for the morrow's sun to rise that he might see what would happen next. He spoke of the promising infant, the industry of boot-making, which had always stood in the fore-front of Issoire's development. He touched lightly on the late labor difficulties, as a mere incident in the city's progress, "a spark struck out from the clashing of great interests as from flint and steel." "Different directions may produce such," said he, unconsciously quoting from an earlier economist, "nay, different velocities in the same direction." Then he spoke of the value of the octroi to the workingman and of the charmed life he leads at Issoire. He repeated all the arguments drawn from the prices of boots and the prices of labor which the schoolmaster had written out for him, and everything went on beautifully till near the close, when the master-workman Jacques rose to ask a question.

"How is it," said he, "if the lot of the workingman is so pleasant in Issoire, that there is not a single workingman from Issoire in one of the factories in this city? How is it that the mills are

full of paupers and 'rats' from Clermont and Jonas? How is it that the census shows that Issoire is actually poorer to-day than she was ten years ago, that her pauper roll is ten times as large, and the only citizens who have grown rich are the city officers and the members of Issoire's iniquitous Equitable Confidence Societies? If the octroi is to benefit the laborers of Issoire, why don't you put it on the outside fellows who swarm in Issoire, and not on the Issoire laborers' food and clothing? It seems to me, sir, that when a city begins to fix things to help one set of men and then another, rather than to consider the common good of all, it is on dangerous ground. Once started on this sort of thing, everybody clamors for his share. Every man too lazy to work, and every man whose business does not pay, seems to think that the rest of the town owe him a living."

Warming up with the subject, he continued:

"Take this millstone business of yours, for example. It is all folly to talk of the wealth in your stone-quarries, if you have to hire their owners to work them. If we can buy millstones in Clermont for less than it costs to cut them in Issoire, it is money in our pockets to leave them in the ground. If any line of business needs to be constantly propped up, and can not live except at the expense of its neighbors, it is no industry at all. It is a beggary. And this octroi of yours has made a beggar or a brigand of every industry in Issoire!"

But the mayor waved his hand and smiled, and said that some men were never satisfied. They would grumble about the golden pavements of the New Jerusalem, if they could not turn them into legal tender. Then he referred to a conspiracy among men suborned by Clermont gold, to flood the streets of Issoire with cheap bread and meat and potatoes and clothing. He asked all who wanted to be slaves to Clermont to rise and be counted. He showed that, of all people on earth, the people of France were the happiest; of all people in France, those of Issoire were most favored; and of those in Issoire, the best of all were the workingmen, the especial guardians of the Issoire idea.

Meanwhile the extension of the octroi to 3,872 articles had greatly increased the wealth of the city, and the city treasurer's strong-box was so full that he had to make a second one, and to hire three trusty Clermont men to watch it day and night, and then three men from Jonas to watch the first three. What should be done with the money to keep it in circulation, for, if it remained locked up, the wheels of industry would soon begin to creak, and creaking is a sign that wheels need oiling?

The mayor had proposed to divide it among the several Equitable Confidence Societies, in order to encourage industry, and thus enable these companies to raise still higher the high wages

of the men from Jonas, who were now the only laborers employed in Issoire. But this was objected to in several quarters, especially by the followers of the workman Jacques, who did not like to trust the Equitable Societies to make such a division.

The schoolmaster wanted it divided among the school-children pro rata in proportion to their raggedness. This was favored by almost every one, because it would benefit the laboring-man and help on the clothing-trade; but the politicians objected to giving money to the poor, because such giving tends simply to enervate. The very fact that a man is poor shows that he is not fitted to take care of money. Some wanted the city wall built up so high that no one could see out of the town, and then to have the top so beset with broken bottles that no one could climb over. A few of the extreme devotees of the Issoire idea wanted the surplus devoted to destroying the roads to Clermont, that all danger from the flood of cheap goods with which that city stood always ready to overwhelm Issoire would be removed forever. One of the Council even wished to use it for the permanent closing of all the city gates, for, as he said, "if we are good citizens we will have nothing to do with abroad."

But the private secretary of the mayor remarked that altogether too much had been said of this matter of surplus revenue. "It is a good deal easier," he remarked, sagely, "to manage a surplus than a deficit." Then the mayor said: "It is much better to have too much money than too little. That is what constitutes prosperity. I wouldn't mind having a little surplus myself." Then the Council laughed, and each one thought of what he could do with his share of the surplus, while they discussed some plans which looked toward an equitable distribution of it in places where it would do the most good.

The workman Jacques, who was now a member of the Council, and who had been selected as the opposition candidate for mayor, rose and said: "This octroi stuff is all bosh. It is a tax to make things higher, and it comes out of our pockets. That is why we are so poor. The mayor says that it is collected from the Clermont merchants. The mayor lies. What does a Clermont merchant care whether we pay him ten francs for a pair of boots outside the city gates, or twenty francs inside, after he has paid ten francs toll? It is all the same to him. He loses nothing either way, except that our ridiculous laws have lost him a good customer for his woolen goods, and we have lost a good customer for our wines and wheat. If I can save ten francs by buying my boots at Clermont, have I not a right to save it, and whose business is it if I do? The octroi is putting into the city treasury every year fifty thousand francs more than the city has any honest use for, and the whole town will go into bankruptcy if this

goes on for three years more. There isn't money enough in the city to keep up this surplus. The money can not get out of the treasury unless some one steals it out and puts it into circulation; and, if I understand you, gentlemen, this is just what you propose to do."

This speech was the sensation of the day. It was spoken with a blunt earnestness such as well-meaning but ignorant men are often found to possess. Its sophistries were not at first apparent, for the very reason that the speaker himself did not know them to be sophistries.

It was printed next morning in the Issoire "Etoile," and it made many converts among those who were unable to expose its errors. The landlord of the Hôtel de la Poste indorsed it, because the patronage of that excellent hostelry had greatly declined since the cessation of the barter with Clermont. Some of the manufacturers favored it, for they were looking for wider outlets for their trade, as the market of Issoire was soon glutted, and the octroi increased the cost of manufacture even more than it raised the price of the finished goods. The politicians said that it might be true enough, but plain talk like that would ruin any man's chances in a popular election. Jacques should have remembered that he was a candidate. The parson, who seldom meddled with politics, declared that the address was timely and patriotic, and that the real friend of the laboring-man was the man who gave him justice instead of patronage. He further said that, in his opinion, the mayor and Council were wrong in their theories of wealth. Their fundamental error was this, that they were trying to make the people of this city grow rich off each other. He even marched in a procession which went through the streets, carrying banners inscribed: "Vive Jacques, the Master-Workman!" "A bas l'Octroi!" "Away with Useless Taxes!"

But the reaction soon came, as it always comes in the politics of France, and it was due to the Clermont papers. They published Jacques's speech in full, with words of great approbation.

In the Clermont "Libéral" were the head-lines: "Long live Mayor Jacques!" "Down with the Demagogues!" "Issoire coming to her Senses!" "The Workingmen repudiate the Octroi!" "Good Prospects for the Clermont Trade!"

It was on the very eve of the election that the Clermont papers were received in Issoire. It was enough. What sophistry had seduced, patriotism reclaimed. The mayor said that, if Jacques was elected, the octroi would be removed at once, every man in Issoire would be ruined, and the city, bound hand and foot, would be delivered over to Clermont. Ten wagon-loads of goods would be sent in the place of one, and not all the money in the whole city would suffice to pay for them. Then he read from the Cler-

mont "Libéral" an editorial in which Jacques was compared to Arnold Winkelried and to Charles Martel and to St. Austremoine, the first hero of Issoire. The effect was tremendous. Every word from Clermont in praise of Jacques was, as the mayor said, "one more nail in his coffin."

The election-day came at last—as such days always come. It was a bright Sabbath afternoon in early August, for in France elections are always held on Sunday afternoons. The birds sang in the poplar-trees, the wheat-fields looked yellow through the city gates, the Café du Lion d'Or was covered with flags and with red ribbons in honor of Jacques, while the Café de la Comédie was similarly draped in blue in honor of his rival. The people were out in their best clothes and Issoire-made boots, and the candidates were among them—all smiles and attention, though I thought that a slightly misanthropic expression lurked about the big workman's mouth.

The bands played, and rival processions moved about in the street. The longest of these carried banners inscribed "Vive l'Octroi!" "A bas Clermont!" "Le Surplus toujours!" "De Rougeâtre forever!" Everybody seemed falling into line, and so I followed, keeping step with the music.

All at once I heard a fearful, blood-curdling scream. The procession swiftly dissolved, the music ceased, the banners vanished. I rubbed my eyes and looked about me. I was sitting on an inverted nail-keg at the Clermont gate just outside the city of Issoire. The old gendarme who guarded the gate was slowly drawing a dripping sword out of a large bundle of oats, in which he had thrust it while performing his duty as inspector. Within the oats was great excitement. The contraband hog concealed inside was lustily kicking and filling the air with his frantic screams.

And thus I knew that the city had been saved, for the octroi was still going on.

And it is going on yet.

THE HOME OF THE GREAT AUK.

By FREDERIC A. LUCAS.

THE fate of the great auk in its New World home is well known; how it was slaughtered for its flesh, slaughtered for its feathers, slaughtered for the mere wanton love of destruction, until after nearly three centuries of persecution the last great auk disappeared from the face of the earth. All this has been described, so that the bird and its history are fairly well known.

Less, however, has been written of its chosen breeding-grounds, as these were usually outlying islands of difficult access, but little frequented now by those who have either time or desire to devote

to the subject. It was the good fortune of the writer, during the summer of 1887, to visit the favorite resort of the great auk.

This spot, lying thirty-two miles to the north and east of Cape Freels, Newfoundland, is Funk Island, whose granite sides and outlying reefs form a constant menace to the few vessels navigating the adjacent waters. Separated from it by intervals of six hundred and twelve hundred yards are two small, low islets, washed completely over in storms, the three constituting the group known as the Funks, although popularly the plural is often used when speaking of the larger island only. The locality is of considerable interest to the St. John's sealers, from the fact that the vast herds of seals that drift down from the north in the early spring are usually encountered and slain somewhere in this vicinity.

But to the ornithologist the chief interest of Funk Island will ever lie in its having been the headquarters of the great auk, the number of birds frequenting other localities being insignificant when compared with the feathered legions who dwelt on the granite cliffs of this lonely spot. Should this be doubted, it must be remembered that the work of extermination required more than two centuries of slaughter, while to-day the soil is whitened by the fragments of myriads of egg-shells.

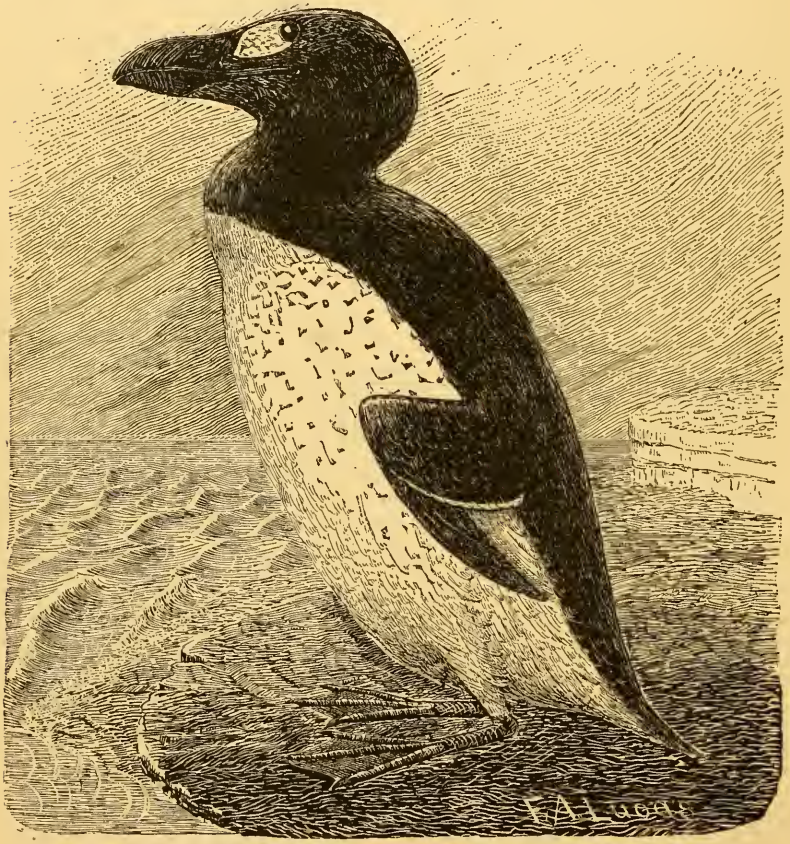
The writer had long been desirous of procuring some bones of the great auk for the United States National Museum; and when in the spring of 1887 it was found that the work of the United States Fish Commission would take the schooner Grampus along the eastern coast of Newfoundland, it was decided that she should visit Funk Island, and he was detailed to accompany her. Daybreak on the morning of July 22d found the vessel about ten miles distant from the Funks, toward which she was slowly progressing before a light but fortunately favorable wind. But for the distance intervening between the schooner and her destination the weather would have been pronounced simply perfect, for fine weather is by no means common in this latitude, and yet it is essential for landing on this rocky outpost.* The morning wore slowly on, and not until noon was the Grampus near enough for a boat to be lowered and a start made for the shore.

The plan agreed upon was to take ashore in the first boat all things needful for a stay of several days, so that, a landing once effected, we would not be forced to quit the island by threatening weather, but could remain and prosecute our work, while the schooner sought safer quarters than near the breakers, which in rough weather are found in the vicinity of Funk Island. It was, therefore, with a well-loaded dory that we left the Grampus a mile

* A short time after our departure a French collector spent some time at the Funks, vainly waiting for an opportunity to land, and finally departed unsuccessful.

from the northeastern point and pulled briskly in to look for a landing-place.

Viewing the island from a distance, it had appeared possible, with the light breeze then blowing, to beach a boat on the southerly slope; but, on closer approach, the seemingly narrow line of foam fringing the shelving rock had become transformed into the wash of a heavy swell upon a steep and slippery shore of granite, on which landing was quite out of the question.



THE GREAT AUK.

Indefinite as was most of the information gathered in regard to the Funks during a stop at St. John's, all accounts agreed in locating the best landing on the northern side, not far from Escape Point, the eastern extremity. To this spot, known as the "Bench," we were also directed by the crew of a fishing-boat near by; and, passing the point on which the smooth swells broke into ragged patches of foam, a few minutes later found our boat lying at the foot of a low cliff, whose weathered side rose almost perpendicularly from the water. Right in the face of this cliff is a nar-

row natural path leading from near the level of the sea to perhaps twenty feet above it. The path at its widest is four feet across, but from this it tapers either way to nothing, the upper end terminating in a fissure just large enough to accommodate one's foot, the rough, weathered granite forming a very good substitute for a hand-rail. Indeed, Nature has probably never devised a better rock for climbing purposes than the coarse-grained, feldspathic granite composing Funk Island, which weathers into crannies and projections whose rough surfaces offer secure support for hand and foot.

Below the "Bench" the cliff descends almost vertically to a depth of one hundred and twenty feet beneath the sea, this combination of deep water and perpendicular rock offering no obstacle to chafe the sea into breaking, so that, but for the never-ceasing rise and fall of the swell, one almost seems to be lying beside some huge pier. This landing, however, is only practicable during a calm or with a southerly wind; and, smooth as it was at the time of our visit, the boat rose and fell with every heave of the ocean from four to six feet. With a northerly wind, boats seek a more precarious landing at the southwestern extremity of the island.

Once on the "Bench," to which we hastened to transfer ourselves and all our baggage, it is an easy matter to reach the summit of the island, either by scrambling directly up the rock or by an easier but longer zigzag path.

The result of a careful study of the island during the forenoon had been a unanimous decision that the precipitous character of a large portion of the shore hardly bore out Prof. Milne's simile of its likeness to an upturned saucer. Viewed from the eastern bluffs, it looks not only steep but larger and higher than most accounts would lead one to suppose. Its greatest length seems over half a mile, and its greatest width something over a quarter; so that Cartier, who came here in 1532 and 1534, can not be far out of the way when he says "it containeth about a league in circuit." While it may be a little presumptuous to question the height of forty-six feet given on the chart, nevertheless sixty feet would apparently be much nearer the mark.

Two faults, deepened by time into shallow valleys, divide the island into three ridges running almost east and west. The northern and central of these are bare rock, for the most part smoothed and rounded by rain and ice, but here and there weathered into curious, overlapping ledges. Here, where there is no soil whatever, the smell of guano arising from the droppings of the murres and puffins is quite noticeable, but elsewhere there is but little odor, and that due to the puffins. Rain has washed the soluble matter from the ancient soil of the island, while the heaps of auk

EGG OF THE GREAT AUK.

The great auk's egg, of which a natural-size representation is given in the accompanying figure, was recently sold at auction in England for £225; this is the highest price ever given for a single egg at any auction in England. This one was bought by its late owner, in 1851, for £18. Of the sixty-seven recorded specimens of this egg, forty-four are in Great Britain. Some two hundred and fifty years ago, vessels fishing on the Banks of Newfoundland made great use of these birds for provisions. They were plentiful in that vicinity, and when found on land could be captured wholesale by simply placing a plank from the shore to a boat, up which the auks could be driven. Having no power of flight, the species gradually disappeared from America, and from Europe not long after, the last two specimens of which there is trustworthy evidence having been killed in Iceland in 1844.

bodies long ago crumbled away, yielding up the odor they may once have possessed.

Between the central and southern rise are numerous shallow pools of rain-water, rendered brackish by the driving spray, but still fresh enough to be drunk in case of emergency. Just such an emergency befell a party of eggers some twenty years ago when their schooner was forced away by stress of weather, leaving the men who had landed to subsist for eleven days on a varied diet of eggs, birds, and brackish water.

On the western portion of the southernmost swell of rock lie the former breeding-grounds of the great auk, now mapped out in rich green by the rank vegetation covering this, the soil-clad part of the island. This section alone was accessible to the flightless garefowl, and here in days gone by the great auk scrambled through the breakers and over the slippery rocks, which north and south slope into the sea, to reach its nesting-place. Here, to-day, its bones lie buried in the shallow soil, every weathered slab of granite marking the resting-place of some ill-fated bird. The industrious puffins, whose labors have everywhere honey-combed the ground, play the part of resurrectionists, and the entrance to

each burrow is ornamented by a little heap of slowly whitening bones.

To our party these little osteological collections were a goodly sight, settling at once the question of finding remains of the great auk, and indicating by their presence the existence of other bones yet to be brought to light. Fortunately, the anatomy of the great auk is peculiar, so that there could be no doubt but what the bones here and there strewed on the surface were the bones we had come so far to seek.

There is not the slightest possibility of any bone of the razor-bill or murre being mistaken for that of their huge relative the great auk; and, in fact, of all the bones exhumed, there was little more than a handful belonging to any bird save this giant among auks.

Crowning the summit of the island are the ruins of a stone hut, years ago the winter quarters of a sealing-party, placed here to await the coming of the seals on the drifting ice of early spring. The experiment resulted fatally, for all save the cook were drowned while hunting, and he, the sole survivor, was almost insane when rescued.

Not far from here, an old chest, peeping from beneath a pile of stone, marks the grave of another sealer, a young man from Green Bay, who, carried out into the fog by drifting ice, perished miserably near this forlorn spot.

Near by are the almost obliterated walls of two small structures, overgrown with weeds, which in default of any tradition may be surmised to be the dwellings of the old-time destroyers of the auk.

The stones of which these huts were built, as well as those forming the inclosures in which the auks were confined to await their slaughter, were quarried by Nature from the granite rock of the island. Time and frost split this into blocks of varying size and thickness, and, just where the great auks were most abundant, just there the slabs of stone lay thickest, as if Nature wished to aid man in his work of destruction.

There are no bowlders of foreign origin on this part of the island, nor did we see any along the sloping northwestern shore, although Prof. Milne found some there at the time of his visit in 1874. Many of the inclosures just alluded to ("compounds" they were termed) have disappeared, but others are still distinctly outlined, although most of the stone slabs composing them now lie prostrate. The two best-preserved pens, located some little distance from the southwestern landing, are about twelve feet square, and not one block of stone is missing.

Close by these compounds we upturned the sod over a circle ten feet in diameter, beneath which the soil was composed of

charcoal and auk-bones, the charred condition of the latter testifying to the truth of the accounts that the fat bodies of the slain birds were used as fuel to heat water for scalding their companions—a near approach to seething the kid in its mother's milk. Other cooking places, where the birds were scalded and plucked, lie scattered along the crest of the southern slope, although it is only by much digging that their existence is brought to light. An excavation made near the best-preserved pens revealed the fact that here was probably one of the last places where the great auk was taken. Scarcely two inches of turf covered the shallow soil in which lay imbedded a few fresh-looking bones of the great auk, mixed with others belonging to its relative, the murre. Evidently, the great auk was even then on the wane; its numbers were no longer sufficient to supply the demands of the feather-hunters, who, like their successors, promptly supplied the deficiency with the next bird at hand.

The great auk, by the way, is not the only bird exterminated on Funk Island, for the gannet lives only in the name, Gannet Head, although it was abundant in the time of Cartier, and, according to report, still lingered thirty years ago.

Thanks to the efforts of the eggers, the numbers of all birds breeding here have greatly lessened during the last twenty years, and only the puffin, whose security lies in his burrow, seems able to hold his own.

The soil of Funk Island is in two distinct layers, the lower of which, mostly formed during the occupancy of the great auk, is from three inches to a foot in thickness. Next the bed-rock lie a few angular pebbles, of various sizes, mixed with and covered by a deposit containing innumerable fragments of egg-shells, the whole having a yellowish-gray appearance. Even were there but few bones present, the character of this stratum is in itself sufficient to indicate the immense number of auks formerly breeding here, as well as the length of time during which they made Funk Island their resort. Also, were there no testimony to the contrary, the shallowness of the soil would show the inaccuracy of those writers who state that the great auk nested in a burrow. The upper stratum of soil has been formed since the extermination of the auks, principally by the growth and decay of the vegetation, nourished by their decomposing bodies. This fine, dark-colored, superficial layer, covered with thick, loose turf, formed by the matted roots of plants, also varies in thickness from three or four inches to a foot. In it are found the great majority of bones, the patches of charcoal indicating the location of the cooking-places, and, very rarely, linings of eggs in a more or less dilapidated condition.

By far the best-preserved remains occur in the older soil, where

they are less exposed to the action of the weather, so that, contrary to what might have been expected, the more recently killed birds are the poorest for anatomical purposes.

These Alcine remains, if one may judge from the brief accounts of the few visits made to Funk Island, are rapidly deteriorating. Thus, in 1863, a party of guano-seekers came upon four nearly entire, dried-up bodies; while, in 1874, Prof. Milne secured in half an hour bones representing fifty individuals from which four more or less complete skeletons were reconstructed.

In 1887 our party passed the better part of two busy days in the work of excavating bones of the great auk; and, although the material secured represents hundreds of individuals, it may not make more than a dozen skeletons, and these not all absolutely perfect.

So difficult is it to procure certain bones in a good state of preservation, that the collection of the United States National Museum contains but a single perfect sternum, and one nearly perfect pelvis. Twenty-five years have elapsed since the "mummies" were secured; and while it is quite possible that others may yet be exhumed, it will be either by rare good fortune or an unlimited amount of digging, for, in the hope of coming upon a "mummy," many holes were sunk quite to the bed-rock, but without success. Curiously enough, these bones rarely bear any mark to indicate that the birds were killed by stick or knife, a fact which caused Prof. Milne to remark that this "leads to the supposition that the birds may have died peacefully." Birds that die peacefully, however, seem to have a habit of making away with their skeletons, and on Funk Island there are few bones to be found of any bird save the great auk.*

Even in the immense guano deposits of the Chincha Islands, where the perfect dryness of the soil is unusually favorable to the preservation of inhumed specimens, bird remains are of rare occurrence.

Some of the crania, too, found on Funk Island, bear fractures that must have been caused by a heavy blow, and one specimen met with had evidently come to its death from the stroke of a knife. Prof. Milne's second surmise, that the bones "were the remains of some great slaughter, when the birds had been killed, parboiled, and despoiled only of their feathers; after which they were thrown in a heap," is undoubtedly correct. Not only is the conjecture borne out by current tradition, and by the intermingled condition of the skeletons, but by the distorted appearance of many bones, which, like the ribs, pelvis, and wish-bone, would be most easily affected by pressure.

* Since this was written I have had time to examine the material more carefully, and find that a large number of the crania are fractured.

The mixed state of the bones, for which the busy puffins are to some extent responsible, renders it absolutely impossible to secure the skeleton of any given individual, and makes it necessary to procure a large number of bones in order that there should be the least chance of reconstructing an entire specimen. A skeleton recently mounted for the exhibition series of the United States National Museum is absolutely perfect, while the number of bones secured by our party on the Grampus probably exceeds that of all other collections combined. Some of these are naturally in a poor state of preservation, but others are quite perfect, and, save for their discoloration, in as good condition as if buried only for two or three years.

It would scarcely be just to close this article without giving all due credit to Captain J. W. Collins, whose cordial support of the proposed expedition finally determined the sending of the Grampus to Funk Island, and made the trip so decidedly a success. The thanks of the party are also tendered to the Rev. M. Harvey, of St. John's, for the advice and information so cheerfully given them.

THE ETHICS OF KANT.

By HERBERT SPENCER.

IF, before Kant uttered that often-quoted saying in which, with the stars of Heaven he coupled the conscience of Man, as being the two things that excited his awe, he had known more of Man than he did, he would probably have expressed himself somewhat otherwise. Not, indeed, that the conscience of Man is not wonderful enough, whatever be its supposed genesis; but the wonderfulness of it is of a different kind according as we assume it to have been supernaturally given or infer that it has been naturally evolved. The knowledge of Man in that large sense which Anthropology expresses, had made, in Kant's day, but small advances. The books of travel were relatively few, and the facts which they contained concerning the human mind as existing in different races, had not been gathered together and generalized. In our days, the conscience of Man as inductively known has none of that universality of presence and unity of nature which Kant's saying tacitly assumes. Sir John Lubbock writes:

"In fact, I believe that the lower races of men may be said to be deficient in the idea of right. . . . That there should be any races of men so deficient in moral feeling, was altogether opposed to the preconceived ideas with which I commenced the study of savage life, and I have arrived at the conviction by slow degrees, and even with reluctance."—*Origin of Civilization*, 1882, pp. 404, 405.

But now let us look at the evidence from which this impression

is derived, as we find it in the testimonies of travelers and missionaries.

Praising his deceased son, Tui Thakau, a Fijian Chief, concluded "by speaking of his daring spirit and consummate cruelty, as he could kill his own wives if they offended him, and eat them afterwards."—*Western Pacific.* J. E. ERSKINE, p. 248.

"Shedding of blood is to him no crime, but a glory . . . to be somehow an acknowledged murderer is the object of the Fijian's restless ambition."—*Fiji and the Fijians.* Rev. T. WILLIAMS, i, p. 112.

"It is a melancholy fact that when they [the Zulu boys] have arrived at a very early age, should their mothers attempt to chastise them, such is the law, that these lads are at the moment allowed to kill their mothers."—*Travels and Adventures in Southern Africa.* G. THOMPSON, ii, p. 418.

"Murther, adultery, thievery, and all other such like crimes, are here [Gold Coast] accounted no sins."—*Description of the Coast of Guinea.* W. BOSMAN, p. 130.

"The accusing conscience is unknown to him [the East African]. His only fear after committing a treacherous murder is that of being haunted by the angry ghost of the dead."—*Lake Regions of Central Africa.* R. F. BURTON, ii, p. 336.

"I never could make them [East Africans] understand the existence of good principle."—*The Albert N'yanza.* S. W. BAKER, i, p. 241.

"The Damaras kill useless and worn-out people: even sons smother their sick fathers."—*Narrative of an Explorer in Tropical South Africa.* F. GALTON, p. 112.

The Damaras "seem to have no perceptible notion of right and wrong."—*Ibid.*, p. 72.

Against these we may set some converse facts. At the other extreme we have a few Eastern tribes—pagans they are called—who practice the virtues which Western nations—Christians they are called—do but teach. While Europeans thirst for blood revenge in much the same way as the lowest savages, there are some simple peoples of the Indian Hills, as the Lepchas, who "are singularly forgiving of injuries;"* and Campbell exemplifies "the effect of a very strong sense of duty † on one of these savages." That character which the creed of Christendom is supposed to foster, is exhibited in high degree by the Arafuras (Papuans) who live in "peace and brotherly love with one another" ‡ to such extent that government is but nominal. And concerning various of the Indian Hill-tribes, as the Santáls, Sowrahs, Marias, Lepchas, Bodo and Dhimáls, different observers testify of them severally that "they were the most truthful set of men I ever met," # "crime and criminal officers are almost unknown," ‖ "a pleasing feature in their character is their complete truthfulness," △ "they bear a

* Campbell in "Journal of the Ethnological Society," N. S., vol. i, 1869, p. 150.

† Ibid., p. 154.

‡ Dr. H. Kolff. "Voyages of the Dutch brig 'Dourga.'" Earl's translation, pp. 161, 163.

W. W. Hunter. "Annals of Rural Bengal," p. 248.

‖ Ibid., p. 217.

△ Dr. J. Shortt. "Hillranges of Southern India," pt. iii, p. 38.

singular character for truthfulness and honesty,"* they are "wonderfully honest,"† "honest and truthful in deed and word."‡ Irrespective of race, we find these traits in men who are, and have long been, absolutely peaceful (the uniform antecedent); be they the Jakuns of the South Malayan Peninsula, who "are never known to steal anything, not even the most insignificant trifle,"# or be it in the Hos of the Himalaya, among whom "a reflection on a man's honesty or veracity may be sufficient to send him to self-destruction."‖ So that in respect of conscience these uncivilized people are superior to average Europeans, as average Europeans are superior to the brutal savages previously described.

Had Kant had these and kindred facts before him, his conception of the human mind, and consequently his ethical conception, would scarcely have been what they were. Believing, as he did, that one object of his awe—the stellar Universe—has been evolved, he might by evidence like the foregoing have been led to suspect that the other object of his awe—the human conscience—has been evolved; and has consequently a real nature unlike its apparent nature.

For the disciples of Kant living in our day, there can be made no such defense as that which may be made for their master. On all sides of them lie classes of facts of various kinds, which might suffice to make them hesitate, if nothing more. Here are a few such classes of facts.

Though, unlike the uncultured who suppose everything to be what it appears, chemists had, for many generations, known that multitudinous substances which seem simple are really compound, and often highly compound; yet, until the time of Sir Humphry Davy, even they had believed that certain substances which, besides seeming simple resisted all their powers of decomposition, were to be classed among the elements. Davy, however, by subjecting the alkalies to a force not before applied, proved that they are oxides of metals; and, suspecting the like to be the case with the earths, similarly proved the composite nature of these also. Not only the common sense of the uncultured but the common sense of the cultured was shown to be wrong. Wider knowledge has, as usual, led to greater modesty; and since Davy's day chemists have felt less certain that the so-called elements are elementary. Contrariwise, increasing evidence of sundry kinds leads

* Glasfind in "Selections from the Records of Government of India" (Foreign Department), No. xxxix, p. 41.

† Campbell in "Journal of the Ethnological Society," N. S., vol. i, 1869, p. 150.

‡ B. H. Hodgson in "Journal of the Asiatic Society of Bengal," xviii, p. 745.

Rev. P. Favre in "Journal of the Indian Archipelago," ii, p. 266.

‖ Col. E. T. Dalton. "Descriptive Ethnology of Bengal," p. 206.

them to suspect more and more strongly that they are all compound.

Alike to the laborer who digs it out and to the carpenter who uses it in his workshop, a piece of chalk appears a thing than which nothing can be simpler; and ninety-nine people out of a hundred would agree with them. Yet a piece of chalk is highly complex. A microscope shows it to consist of myriads of shells of *Foraminifera;* shows further that it contains more kinds than one; and shows further still that each minute shell, whole or broken, is formed of many chambers, every one of which once contained a living unit. Thus by ordinary inspection, however close, the true nature of chalk can not be known; and to one who has absolute confidence in his eyes the assertion of its true nature appears absurd.

Take again a living body of a seemingly uncomplicated kind—say a potato. Cut it through and observe how structureless its substance. But though unaided vision gives this verdict, aided vision gives a widely different one. Aided vision discovers, in the first place, that the mass is everywhere permeated by vessels of complex formation. Further, that it is made up of innumerable units called cells, each of which has walls composed of several layers. Further still, that each cell contains a number of starch-grains. And yet still further, that each of these grains is formed of layer within layer, like the coats of an onion. So that where there seems perfect simplicity there is really complexity within complexity.

From these examples which the objective world furnishes, let us turn to some examples furnished by the subjective world—some of our states of consciousness. Up to modern times any one who, looking out on the snow, was told that the impression of whiteness it gave him was composed of impressions such as those given by the rainbow, would have regarded his informant as a lunatic; as would even now the great mass of mankind. But since Newton's day, it has become well known to a relatively small number that this is literal fact. Not only may white light be resolved by a prism into a number of brilliant colors, but by an appropriate arrangement these colors can be re-combined into white light. Those who habitually suppose that things are what they seem, are wrong here as in multitudinous other cases.

Another example is supplied by the sensation of sound. A solitary note struck on the piano, or a blast from a horn, yields through the ear a feeling which appears homogeneous; and the uninstructed are incredulous if told that it is an intricate combination of noises. In the first place, that which constitutes the more voluminous part of the tone is accompanied by a number of over-tones, producing what is known as its *timbre:* instead of one

note, there are half a dozen notes, of which the chief has its character specialized by the others. In the second place, each of these notes, consisting objectively of a rapid series of aërial waves, produces subjectively a rapid series of impressions on the auditory nerve. Either by Savart's machine or by the siren, it is proved to demonstration that every musical sound is the product of successive units of sound, each in itself unmusical, which, as they succeed one another with increasing rapidity, produce a tone which progressively rises in pitch. Here again, then, under an apparent simplicity there is a double complexity.

Most of these examples of the illusiveness of unaided perception, whether exercised upon objective or subjective existences, were unknown to Kant. Had they been known to him they might have suggested other views concerning certain of our states of consciousness, and might have given a different character to his philosophy. Let us observe what would possibly have been the changes in two of his cardinal conceptions—metaphysical and ethical.

Our consciousness of Time and Space appeared to him, as they appear to every one, perfectly simple; and the apparent simplicity he accepted as actual simplicity. Had he suspected that, just as the seemingly homogeneous and undecomposable consciousness of Sound really consists of multitudinous units of consciousness, so might the apparently homogeneous and undecomposable consciousness of Space, he would possibly have been led to inquire whether the consciousness of Space is not wholly composed of infinitely numerous relations of position, such as those which every portion of it presents. And finding that every portion of Space, immense or minute, can not be either known or conceived save in some relative position to the conscious subject, and that, besides involving the relations of distance and direction, it invariably contains within itself relations of right and left, top and bottom, nearer and further; he might perhaps have concluded that our consciousness of that matrix of phenomena we call Space, has been built up in the course of Evolution by accumulated experiences registered in the nervous system. And had he concluded this, he would not have committed himself to the many absurdities which his doctrine involves.*

Similarly, if, instead of assuming that conscience is simple because it seems simple to careless introspection, he had entertained the hypothesis that it is perhaps complex—a consolidated product of multitudinous experiences received mainly by ancestors and added to by self—he might have arrived at a consistent system of Ethics. That the habitual association of pains with certain

* See "Principles of Psychology," § 399.

things and acts, generation after generation, may produce organic repugnance to such things and acts,* might, had it been known to him, have made him suspect that conscience is a product of Evolution. And in that case his conception of it would not have been incongruous with the facts above named, showing that there are widely different degrees of conscience in different races.

In brief, as already implied, had Kant, instead of his incongruous beliefs that the celestial bodies have had an evolutionary origin, but that the minds of living beings on them, or at least on one of them, have had a non-evolutionary origin, entertained the belief that both have arisen by Evolution, he would have been saved from the impossibilities of his Metaphysics, and the untenabilities of his Ethics. To the consideration of these last, let us now pass.

Before doing this, however, something must be said concerning abnormal reasoning as compared with normal reasoning.

Knowledge which is of the highest order in respect of certainty, and which we call exact science, is distinguished from other knowledge by its definitely quantitative previsions.† It sets out with data, and proceeds by steps, which, taken together, enable it to say under what specified conditions a specified relation of phenomena will be found; and to say in what place, or at what time, or in what quantity, or all of them, a certain effect will be witnessed. Given the factors of any arithmetical operation, and there is absolute certainty in the result reached, supposing there are no stumblings: stumblings which always admit of detection and disproof by the method which we shall presently find is pursued. Base and angles having been accurately measured, geometry yields with certainty the distance or the height of the object of which the position is sought. The ratio of the arms of a lever having been stated, mechanics tells us what weight at one end will balance an assigned weight at the other. And by the aid of these three exact sciences, the Calculus, Geometry, and Mechanics, Astronomy can predict to the minute, for each separate place on the Earth, when an eclipse will begin and end, and how near it will approach to totality. Knowledge of this order has infinite justifications in the successful guidance of infinitely numerous human actions. The accounts of every trader, the operations of every workshop, the navigation of every vessel, depend for their trustworthiness on these sciences. The method they pursue, therefore, verified in cases which pass all human power to enumerate, is a method not to be transcended in certainty.

What is this method? Whichever of these sciences we exam-

* See "Principles of Psychology," § 189 (note) and § 520.

† See Essay on "Genesis of Science."

ine, we find the course uniformly pursued to be that of setting out with propositions of which the negations are inconceivable, and advancing by successive dependent propositions, each of which has the like character—that its negation is inconceivable. In a developed consciousness (and of course I exclude minds of which the faculties are unformed) it is impossible to represent things that are equal to the same thing as being themselves unequal; and in a developed consciousness, action and re-action can not be thought of as other than equal. In like manner, every *because*, and every *therefore*, used in a mathematical argument, connotes a proposition of which the terms are absolutely coherent in the mode alleged: the proof being that an attempt to bring together in consciousness the terms of the opposite proposition is futile. And this method of testing, alike the fundamental propositions and all members of the fabric of propositions raised upon them, is consistently pursued in verifying the conclusion. Inference and observation are compared; and when they agree, it is inconceivable that the inference is other than true.

In contrast to the method which I have just described, distinguishable as the legitimate *a priori* method, there is one which may be called—I was about to say, the illegitimate *a priori* method; but the word is not strong enough: it must be called the inverted *a priori* method. Instead of setting out with a proposition of which the negation is inconceivable, it sets out with a proposition of which the affirmation is inconceivable, and therefrom proceeds to draw conclusions. It is not consistent, however: it does not continue to do that which it does at first. Having posited an inconceivable proposition to begin with, it does not frame its argument out of a series of inconceivable propositions. All steps after the first are of the kind ordinarily accepted as valid. The successive *therefores* and *becauses* have the usual connotations. The peculiarity lies in this, that in every proposition save the first, the reader is expected to admit the logical necessity of an inference drawn, for the reason that the opposite is not thinkable; but he is not supposed to expect a like conformity to logical necessity in the primary proposition. The dictum of a logical consciousness which must be recognized as valid in every subsequent step, must be ignored in the first step. We pass now to an illustration of this method which here concerns us.

The first sentence in Kant's first chapter runs thus: "Nothing can possibly be conceived in the world, or even out of it, which can be called good without qualification, except a Good Will." And then on the next page we come upon the following definition:

"A good will is good not because of what it performs or effects, nor by its aptness for the attainment of some proposed end, but simply by virtue of the volition, that is, it is good in itself, and considered by itself is to be esteemed much higher than all that can be brought about by it in favor of any inclination, nay even of the sum total of all inclinations."

Most fallacies result from the habit of using words without fully rendering them into thoughts—passing them by with recognitions of their meanings as ordinarily used, without stopping to consider whether these meanings admit of being given to them in the cases named. Let us not rest satisfied with thinking vaguely of what is understood by "a Good Will," but let us interpret the words definitely. Will implies the consciousness of some end to be achieved. Exclude from it every idea of purpose, and the conception of Will disappears. An end of some kind being necessarily implied by the conception of Will, the quality of the Will is determined by the quality of the end contemplated. Will itself, considered apart from any distinguishing epithet, is not cognizable by Morality at all. It becomes cognizable by Morality only when it gains its character as good or bad by virtue of its contemplated end as good or bad. If any one doubts this, let him try whether he can think of a good will which contemplates a bad end. The whole question, therefore, centers in the meaning of the word good. Let us look at the meanings habitually given to it.

We speak of good meat, good bread, good wine; by which phrases we mean either things that are palatable, and so give pleasure, or things that are wholesome, and by conducing to health conduce to pleasure. A good fire, good clothing, a good house, we so name because they minister either to comfort, which means pleasure, or gratify the æsthetic sentiment, which also means pleasure. So it is with things which more indirectly further welfare, as good tools or good roads. When we speak of a good workman, a good teacher, a good doctor, it is the same: efficiency in aiding others' well-being is what we indirectly mean. Yet again, good government, good institutions, good laws, connote benefits yielded to the society in which they exist: benefits being equivalent to certain kinds of happiness, positive or negative. But Kant tells us that a good will is one that is good in and for itself without reference to ends. We are not to think of it as prompting acts which will profit the man himself, either by conducing to his health, advancing his culture, or improving his inclinations; for all these are in the long run conducive to happiness, and are urged only for the reason that they do this. We are not to think of a will as good because, by fulfillment of it, friends are saved from sufferings or have their gratifications increased; for this would involve calling it good because of bene-

ficial ends in view. Nor must conduciveness to social ameliorations, present or future, be taken into account when we attempt to conceive a good will. In short we are to frame our idea of a good will without any material out of which to frame the idea of good: good is to be used in thought as an eviscerated term.

Here, then, we have illustrated what I have called above the inverted *a priori* method of philosophizing: the setting out with an inconceivable proposition. The Kantian Metaphysics starts by asserting that Space is "nothing but" a form of intuition—pertains wholly to the subject and not at all to the object. This is a verbally intelligible proposition but one of which the terms can not be put together in consciousness; for neither Kant, nor any one else, has ever succeeded in bringing into unity of representation the thought of Space and the thought of Self, as being the one an attribute of the other. And here we see that, just in the same way, the Kantian Ethics begins by positing something which seems to have a meaning but which has really no meaning—something which, under the conditions imposed, can not be rendered into thought at all. For neither he, nor any one else, ever has or ever can, frame a consciousness of a good will when from the word good are expelled all thoughts of those ends which we distinguish by the word good.

Evidently Kant himself sees that his assumption invites attack, for he proceeds to defend it. He says:

"There is, however, something so strange in this idea of the absolute value of the mere will, in which no account is taken of its utility, that notwithstanding the thorough assent of even common reason to the idea, [!] yet a suspicion must arise that it may perhaps really be the product of high-flown fancy, &c." (p. 13).

And then to prepare for a justification, he goes on to say:

"In the physical constitution of an organized being we assume it as a fundamental principle that no organ for any purpose will be found in it but what is also the fittest and best adapted for that purpose" (pp. 13–14).

Now, even had this assumption been valid, the argument based upon it, far-fetched as it is, might be considered of very inadequate strength to warrant the supposition that there can be a will conceived as good without any reference to good ends. But, unfortunately for Kant, the assumption is utterly invalid. In his day, it probably passed without question; but in our day, few if any biologists would admit it. On the special-creation hypothesis some defense of the proposition might be attempted, but the evolution hypothesis tacitly negatives it entirely. Let us begin with some minor facts which militate against Kant's supposition. Take first rudimentary organs. These are numerous throughout the animal kingdom. While representing organs which were of use

in ancestral types, they are of no use in the types possessing them; and as being rudimentary they are of necessity imperfect. Moreover besides being injurious as taxing nutrition to no purpose, they are almost certainly in some cases injurious by being in the way. Then, beyond the argument from rudimentary organs, there is the argument from make-shift organs, which form a large class. We have a conspicuous case in the swimming organ of the seal, formed by the apposition of the two hind limbs —an organ manifestly inferior to one specially shaped for its function, and one which during early stages of the changes which have produced it must have been inefficient. But the untruth of the assumption is best shown by comparing a given organ in a low type of creature with the same organ in a high type. The alimentary canal, for example, in very inferior creatures is a simple tube, substantially alike from end to end, and having throughout all its parts the same function. But in a superior creature this tube is differentiated into œsophagus, stomach (or stomachs), small and large intestines with their various appended glands pouring in secretions. Now if this last form of alimentary canal is to be regarded as a perfect organ, or something like it, what shall we say of the original form; and what shall we say of all those forms lying between the two? The vascular system, again, furnishes a clear instance. The primitive heart is nothing but a dilatation of the great blood-vessel—a pulsatile sac. But a mammal has a four-chambered heart with valves, by the aid of which the blood is propelled through the lungs for aëration, and throughout the system at large for general purposes. If this four-chambered heart is a perfect organ, what is the primitive heart, and what are the hearts possessed by all the multitudinous creatures below the higher *vertebrata?* Manifestly the process of evolution implies a continual replacing of creatures having inferior organs, by creatures having superior organs; leaving such of the inferior as can survive to occupy inferior spheres of life. This is not only so throughout the whole animal creation up to Man himself, but it is so within the limits of the human race. Both the brains and the lower limbs of various inferior races are ineffective organs, compared with those of superior races. Nay, even in the highest type of Man we have obvious imperfections. The structure of the groin is imperfect: the frequent ruptures which result from it would have been prevented by closure of the inguinal rings during fœtal life after they had performed their office. That all-important organ the vertebral column, too, is as yet but incompletely adapted to the upright posture. Only while the vigor is considerable can there be maintained, without appreciable effort, those muscular contractions which produce the sigmoid flexure, and bring the lumbar portion into such a position that

the "line of direction" falls within it. In young children, in boys and girls who are admonished to "sit up," in weakly people, and in the old, the spine lapses into that convex form characteristic of lower *Primates*. It is the same with the balancing of the head. Only by a muscular strain to which habit makes us insensible, as it does to the exposure of the face to cold, is the head maintained in position: immediately certain cervical muscles are relaxed, the head falls forward; and where there is great debility the chin rests permanently on the chest.

So far, indeed, is the assumption of Kant from being true, that the very reverse is probably true. After contemplating the countless examples of imperfections exhibited in low types of creatures, and decreasing with the ascent to high types, but still exemplified in the highest, any one who concludes, as he may reasonably do, that Evolution has not yet reached its limit, may infer that most likely no such thing as a perfect organ exists. Thus the basis of the argument by which Kant attempts to justify his assumption that there exists a good will apart from a good end, disappears utterly, and leaves his dogma in all its naked unthinkableness.

One of the propositions contained in Kant's first chapter is that "we find that the more a cultivated reason applies itself with deliberate purpose to the enjoyment of life and happiness, so much the more does the man fail of true satisfaction." A preliminary remark to be made on this statement is that in its sweeping form it is not true. I assert that it is untrue on the strength of personal experiences. In the course of my life there have occurred many intervals, averaging a month each, in which the pursuit of happiness was the sole object, and in which happiness was successfully pursued. How successfully may be judged from the fact that I would gladly live over again each of those periods without change, an assertion which I certainly can not make of any portions of my life spent in the daily discharge of duties. That which Kant should have said is that the *exclusive* pursuit of what are distinguished as pleasures and amusements is disappointing. This is doubtless true; and for the obvious reason that it over-exercises one group of faculties, and exhausts them, while it leaves unexercised another group of faculties, which consequently do not yield the gratifications accompanying their exercise. It is not, as Kant says, guidance by "a cultivated reason" which leads to disappointment, but guidance by an uncultivated reason; for a cultivated reason teaches that continuous action of a small part of the nature, joined with inaction of the rest, must end in dissatisfaction.

But now, supposing we accept Kant's statement in full, what is its implication? That happiness is the thing to be desired, and, in one way or another, the thing to be achieved. For if not, what

meaning is there in the statement that it will not be achieved when made the immediate object? One who was thus admonished might properly rejoin: "You say I shall not get happiness if I make it the object of pursuit? Suppose then I do not make it the object of my pursuit; shall I get it? If I do, then your admonition amounts to this, that I shall obtain it better if I proceed in some other way than that I adopt. If I do not get it, then I remain without happiness if I follow your way, just as much as if I follow my own, and nothing is gained." An illustration will best show how the matter stands. To a tyro in archery the instructor says: "Sir, you must not point your arrow directly at the target; if you do, you will inevitably miss it; you must aim high above the target, and you may then possibly pierce the bull's-eye." What now is implied by the warning and the advice? Clearly that the purpose is to hit the target. Otherwise there is no sense in the remark that it will be missed if directly aimed at; and no sense in the remark that to be hit, something higher must be aimed at. Similarly with happiness. There is no sense in the remark that happiness will not be found if it is directly sought, unless happiness is a thing to be somehow or other obtained.

"Yes; there is sense," I hear it said. "Just as it may be that the target is not the thing to be hit at all, either by aiming directly or indirectly at it, but that some other thing is to be hit; so it may be that the thing to be achieved immediately or remotely is not happiness at all, but some other thing: the other thing being duty." In answer to this the admonished man may reasonably say: "What then is meant by Kant's statement that the man who pursues happiness 'fails of true satisfaction'? All happiness is made up of satisfactions. The 'true satisfaction' which Kant offers as an alternative, must be some kind of happiness; and if a truer satisfaction, must be a greater or better happiness; and better must mean on the average, and in the long run, greater. If this 'true satisfaction' does not mean greater happiness of self—distant if not proximate, in another life if not in this life—and if it does not mean greater happiness by achieving the happiness of others; then you propose to me as an end a smaller happiness instead of a greater, and I decline it."

So that in this professed repudiation of happiness as an end, there lies the inavoidable implication that it *is* the end.

This last consideration introduces us naturally to another of Kant's cardinal doctrines. That there may be no mistake in my representation of it, I must make a long quotation.

"I omit here all actions which are already recognized as inconsistent with duty, although they may be useful for this or that purpose, for with these the

question whether they are done *from duty* can not arise at all, since they even conflict with it. I also set aside those actions which really conform to duty, but to which men have *no* direct *inclination*, performing them because they are impelled thereto by some other inclination. For in this case we can readily distinguish whether the action which agrees with duty is done *from duty*, or from a selfish view. It is much harder to make this distinction when the action accords with duty, and the subject has besides a *direct* inclination to it. For example, it is always a matter of duty that a dealer should not overcharge an inexperienced purchaser, and wherever there is much commerce the prudent tradesman does not overcharge, but keeps a fixed price for every one, so that a child buys of him as well as any other. Men are thus *honestly* served; but this is not enough to make us believe that the tradesman has so acted from duty and from principles of honesty: his own advantage required it; it is out of the question in this case to suppose that he might besides have a direct inclination in favor of the buyers, so that, as it were, from love he should give no advantage to one over another [!]. Accordingly the action was done neither from duty nor from direct inclination, but merely with a selfish view. On the other hand, it is a duty to maintain one's life; and, in addition, every one has also a direct inclination to do so. But on this account the often anxious care which most men take for it has no intrinsic worth, and their maxim has no moral import. They preserve their life *as duty requires*, no doubt, but not *because duty requires*. On the other hand, if adversity and hopeless sorrow have completely taken away the relish for life; if the unfortunate one, strong in mind, indignant at his fate rather than desponding or dejected, wishes for death, and yet preserves his life without loving it—not from inclination or fear, but from duty—then his maxim has a moral worth.

"To be beneficent when we can is a duty; and besides this, there are many minds so sympathetically constituted that without any other motive of vanity or self-interest, they find a pleasure in spreading joy around them, and can take delight in the satisfaction of others so far as it is their own work. But I maintain that in such a case an action of this kind, however proper, however amiable it may be, has nevertheless no true moral worth, but is on a level with other inclinations" (pp. 17–19).

I have given this extract at length that there may be fully understood the remarkable doctrine it embodies—a doctrine especially remarkable as exemplified in the last sentence. Let us now consider all that it means.

Before doing this, however, I may remark that, space permitting, it might be shown clearly enough that the assumed distinction between sense of duty and inclination is untenable. The very expression *sense* of duty implies that the mental state signified is a feeling; and if a feeling it must, like other feelings, be gratified by acts of one kind and offended by acts of an opposite kind. If we take the name conscience, which is equivalent to sense of duty, we see the same thing. The common expressions "a tender conscience," "a seared conscience," indicate the perception that conscience is a feeling—a feeling which has its satisfactions and dissatisfactions, and which *inclines* a man to acts which yield the one and avoid the other—produces an *inclination*. The

truth is that conscience, or the sense of duty, is an inclination of a high and complex kind as distinguished from inclinations of lower and simpler kinds.

But let us grant Kant's distinction in an unqualified form. Doing this, let us entertain, too, his proposition that acts of whatever kind done from inclination have no moral worth, and that the only acts having moral worth are those done from a sense of duty. To test this proposition let us follow an example he sets. As he would have the quality of an act judged by supposing it universalized, let us judge of moral worth as he conceives it by making a like supposition. That we may do this effectually let us suppose that it is exemplified not only by every man but by all the acts of every man. Unless Kant alleges that a man may be morally worthy in too high a degree, we must admit that the greater the number of his acts which have moral worth the better. Let us then contemplate him as doing nothing from inclination but everything from a sense of duty.

When he pays the laborer who has done a week's work for him, it is not because letting a man go without wages would be against his inclination, but solely because he sees it to be a duty to fulfill contracts. Such care as he takes of his aged mother is prompted not by tender feeling for her but by the consciousness of filial obligation. When he gives evidence on behalf of a man whom he knows to have been falsely charged, it is not that he would be hurt by seeing the man wrongly punished, but simply in pursuance of a moral intuition showing him that public duty requires him to testify. When he sees a little child in danger of being run over, and steps aside to snatch it away, he does so not because the impending death of the child pains him, but because he knows it is a duty to save life. And so throughout, in all his relations as husband, as friend, as citizen, he thinks always of what the law of right conduct directs, and does it because it is the law of right conduct, not because he satisfies his affections or his sympathies by doing it. This is not all however. Kant's doctrine commits him to something far beyond this. If those acts only have moral worth which are done from a sense of duty, we must not only say that the moral worth of a man is greater in proportion as the number of the acts so done is greater; but we must say that his moral worth is greater in proportion as the strength of his sense of duty is such that he does the right thing not only apart from inclination but against inclination. According to Kant, then, the most moral man is the man whose sense of duty is so strong that he refrains from picking a pocket though he is much tempted to do it; who says of another that which is true though he would like to injure him by a falsehood; who lends money to his brother though he would prefer to see him in distress; who fetches the

doctor to his sick child though death would remove what he feels to be a burden. What, now, shall we think of a world peopled with Kant's typically moral men—men who in the one case, while doing right by one another, do it with indifference and severally know one another to be so doing it, and men who, in the other case, do right by one another notwithstanding the promptings of evil passions to do otherwise, and who severally know themselves surrounded by others similarly prompted? Most people will, I think, say that even in the first case life would be hardly bearable, and that in the second case it would be absolutely intolerable. Had such been men's natures, Schopenhauer would indeed have had good reason for urging that the race should bring itself to an end as quickly as possible.

Contemplate now the doings of one whose acts according to Kant have no moral worth. He goes through his daily work not thinking of duty to wife and child, but having in his thought the pleasure of witnessing their welfare; and on reaching home he delights to see his little girl with rosy cheeks and laughing eyes eating heartily. When he hands back to a shopkeeper the shilling given in excess of right change, he does not stop to ask what the moral law requires: the thought of profiting by the man's mistake is intrinsically repugnant to him. One who is drowning he plunges in to rescue without any idea of duty, but because he can not contemplate without horror the death which threatens. If for a worthy man who is out of employment he takes much trouble to find a place, he does it because the consciousness of the man's difficulties is painful to him, and because he knows that he will benefit not only him but the employer who engages him; no moral maxim enters his mind. When he goes to see a sick friend the gentle tones of his voice and the kindly expression of his face show that he is come not from any sense of obligation but because pity and a desire to raise his friend's spirits have moved him. If he aids in some public measure which helps men to help themselves, it is not in pursuance of the admonition "Do as you would be done by," but because the distresses around make him unhappy and the thought of mitigating them gives him pleasure. And so throughout: he ever does the right thing not in obedience to any injunction, but because he loves the right thing in and for itself. And now who would not like to live in a world where every one was thus characterized?

What, then, shall we think of Kant's conception of moral worth, when, if it were displayed universally in men's acts the world would be intolerable, and when if these same acts were universally performed from inclination, the world would be delightful?

I had intended to criticise, with kindred results I think, three

other cardinal points in Kant's doctrine; but am obliged to abandon the intention. A state of health such that the foregoing pages, commenced in the middle of March, I have been unable to complete till the first week in June, compels me now to desist.

MOSSES AND THEIR WATER-SUPPLY.

By Prof. G. HABERLANDT, of Graz.

THE interest with which botanists regard the mosses is, for various reasons, more lively and more diversified than laymen might suppose so inconspicuous, unobtrusive a group could awaken. In more than one respect, they form a sharply marked point of departure for the morphological and phylogenetical study of the higher plants. The diversified forms of adaptation which these plants, and particularly the leafy mosses, exhibit in their outer and inner structure, are especially worthy of attention. From the fact that they exemplify so many different inclinations in respect to their local relations, and because, notwithstanding the variety in their forms, they are of relatively simple organization, the investigator's insight into their adaptive structure is made comparatively easy; and on more than one occasion their study has greatly aided the understanding of the adaptive phenomena of the more highly developed plants.

An instructive example of the way in which the observation of one order may be applied to facilitate the study of other orders, is afforded in the water-provision of the leafy mosses. Among the simplest in this category are those genera and species that grow on rocks, roofs, and tree-trunks, and are therefore most directly exposed to the rapid exhaustion of atmospheric precipitations. To these belong many *Hypnaceæ*—species of *Gymnostomum, Barbula, Orthotrichum,* etc. No special provisions for taking up water have yet been observed in these species. Their leaves all suck it in when it is abundant and swell out, and then completely dry up again as soon as the air has lost its moisture. It is not the taking in of water that interests us in these mosses, but their complete desiccation, which may occur again and again without harm to the vitality of the plant. In this is expressed a form of adaptation which is invisible to the investigator in microscopic anatomy, and which depends upon undetected properties of the protoplasm. It is evident that this kind of adaptation is most direct and effective, and is in exact conformity with the biological principle of economy of material, in that it makes special protective provisions for the prevention or retardation of the waste of water superfluous. The question arises, Why does this apparently advantageous pro-

tective property of adaptation to desiccation so rarely appear among the higher plants?—why have the plants of the steppes and deserts, for example, to protect themselves against the perils of drought by so various anatomical features, of thick skins, corky bark, waxy and hairy envelopes, receptacles for water, etc., instead of simply drying up and reviving again in the rainy periods? The answer to the question is not hard to find. The maxim, "one thing is not suitable for all," is valid in the biological domain. That which works well in the little mosses is for various reasons not available to the larger phanerogams. First, the larger plants must continue to vegetate actively for longer periods, in order to prepare the amount of food required for the proper growth of their organs. Ever-recurring interruptions of their feeding by drying out would so retard the whole process of their growth, that in spite of their vital tenacity they would be at a great disadvantage in the struggle for existence. To this is added another not less weighty reason, that the mosses are so simple in their anatomical structure that the mechanical shrinking of the drying tissue involves no danger; the collaborated cells easily resume their original form and size on the accession of a new water-supply. It is very different with the organs, far more complicated in their structure and composed of tissue of diversified kinds, of the more highly developed plants. In them extensive shrinkage would result in damaging tensions and distortions, and even cracks, for the limitation of which various mechanical protective adaptations would be required. Besides this, the mechanical structure of the tissues would have to have a proportionately enormous development, else the dry, brittle leaves and branches would be broken up by every gust of wind. A careful regard to the consequences of such an adaptation to complete desiccation should be sufficient to convince any one that it would be too dearly purchased. But in the case of many of the humbler plants insensibility to continuous desiccation is a life-question, and accordingly they have practically acquired that property. It is of equal interest from a physiological and a biological point of view that the protoplasm of the young individual should, by further development, gradually suffer the complete loss of so pregnant a property as that of reviving after it has been dried up.

The power of the mosses to endure repeated desiccation has recently been experimentally treated by G. Schröder,* who obtained the interesting result that many of these plants can not only resist months of dryness without any harm, but also that they do not perish even under the strongest desiccation carried on in a drier with the aid of sulphuric acid. Plants of *Barbula*

* "Ueber die Austrocknungsfähigkeit der Pflanzen." Untersuchen aus dem botanischen Institut zu Tübingen. Published by Pfeffer. Vol. ii, part i, 1886.

muralis, which were exposed for eighteen months in the drier, after a few wettings resumed growth in all their parts. Other species of *Barbula* behaved similarly. A curious experiment was performed with *Grimmia pulvinata,* in which a stock which had been cultivated for some time in a moist atmosphere under a bell-glass was suddenly exposed to a warm and perfectly dry current of air. It became so dry in a short time that it could be pulverized. Then it lay in a drier for ninety-five weeks. But the quickening moisture was still competent to awaken it to renewed life. The most rapid drying which could be performed in the laboratory could not destroy the plant. It even showed greater power of resistance than would correspond with its real necessities, for so speedy and complete a drying out as was effected in the experiments never occurs in Nature. The fact that a property acquired by adaptation is so plainly manifested in excess is sometimes otherwise demonstrable, and is a hard problem for the theory of selection.

Those mosses which are not capable of drawing water in considerable quantities from the soil, are yet able to make the best use of the smaller quantities with which they are moistened. For this object their stems are furnished with provisions for the capillary distribution of the local water with which they are in contact. This capillary "outer water-conduit" was perceived several years ago in various mosses by C. Schimper; and it has recently been more closely studied with the aid of colored solutions by Fr. Oltmann.

The capillary spaces in which the water rises or, more generally speaking, diffuses itself, exist in different forms. In the simplest cases the leaves supply them; and of this kind there are, according to Oltmann's comparisons, several types. Thus in *Hylocomium loreum, Hypnum purum,* and similar forms, the leaves are so shaped and arranged with their opposite sides in close contact as to form a hollow cylinder around the stem, which is composed in its interior of a system of connected chambers. When enough water is present, the capillary space between the stem and the leaf is quite full; in other cases the water ascends only between the overlapping leaf-edges. In *Plageothecium undulatum, Neckera crispa,* etc., the leaves lap like shingles; in other cases they are small and thickly packed, so that a whole system of narrow capillary spaces is generated between them. The frequently observed phenomenon of the drying leaves erecting themselves and lying close to the stem, with wrinklings and curlings, involves, as Oltmann has remarked, an increase of capillary space. By these means the water, when a wetting takes place, is diffused more readily and completely over the surface of the plant.

In another series of cases, the capillary apparatus is formed by

a felting of hairs encompassing the stem, in which water rises as in a piece of filtering paper. *Dicranum undulatum, Climacium dendroides,* and *Hylocomium splendens* are among the species thus furnished. These hair formations commonly resemble the root-hairs, and might eventually be designated as of that class; but in single cases, as in *Thuidium tamariscinum,* they exhibit a peculiar construction. The hairs are undoubtedly adapted to taking up the water with which they come in contact.

With the phanerogams, the plenteous absorption of water by organs above ground is a rare phenomenon of adaptation, and is limited to a number of epiphytes (*Bromelaciæ*) and desert-plants. In these, again, different forms of hair-growth assist the reception of water. Volkens * has recently shown that many of those desert species whose leaves are furnished with a hair-felting absorb rain and dew in this manner. But he has never observed the reception of the water going on over the whole surface of the hair, but only in specific cells at the base of the hair which act as the absorbing element; while the dead cells composing the felt fulfill the purpose of retaining the water, covering the surface of the leaf, and in that way facilitating absorption.

The capillary apparatus of the peat-mosses is peculiar and without any analogies with the more highly developed plants. The leaves of the *Sphagnaceæ* consist of two kinds of elements; of long-drawn, chlorophyll-bearing cells woven into a net-work, and of dead, colorless capillary cells, which form the meshes of the net. The walls of the capillary cells are furnished with large, usually round pores, the points at which the water is admitted, the situation and arrangement of which in many species materially facilitate the passage of the water from one cell to another. The edges of the pores are usually hemmed with a thicker fibrous ring, the office of which is evidently mechanical, or to prevent tearing. The walls of the cells are also stiffened with spirally arranged fibrous structures, like the duct-walls of the more highly developed plants. The stems of the peat-mosses have also a "bark-envelope" from two to four cells thick, which serves as a reservoir and a medium for the circulation of water.

The stems, fruit-stalks, and leaves of numerous mosses possess a water-bearing tissue-cord occupying an axillary position. This cord, which consists of narrow, thin-walled, and elongated cells, has been described by W. Ph. Schimper and Fr. Unger, to whom we owe some excellent researches on the anatomy of the mosses. Its precise physiological function has until very recently not been made clear. While it was not doubted that it had some connection with the circulation, it was not certain whether or not it presented any analogies with the vascular system of the higher

* "The Flora of the Egypto-Arabian Desert." Berlin, 1887, p. 32.

plants. I have within a short time obtained evidence that the typical tissue-cord represents a water-bearing structure. With a solution of sulphate of lithium I found that the average velocity of the circulation through the central cord was not very far behind that which took place in the stems of phanerogamous plants; and that the solution was very quickly transferred from the central cord through the leaves. Experiments in transpiration further showed that the water-bearing capacity of the central cord, where it is well developed, is amply sufficient to supply the water lost by transpiration.

It is a point of interest with respect to the relations between the structure of the central cord and the local conditions of the habitat of the plant, that only those mosses that grow on more or less moist ground have this cord well developed. It is easy to perceive that the cord can be of advantage only where a steady supply and circulation of water for a relatively considerable length of time is possible. To classes fulfilling these conditions belong chiefly the longer leaved and therefore more actively transpiring plants of Mnium, Bryum, Bartramia, Funaria, Fissidens, and Splachnum. On the other hand, the systematic position of the moss appears to be a matter of no account. *Archidium alternifolium*, which grows in moist fields, and which is phylogenetically regarded as one of the lowest of the leaf-mosses, has a typically developed central cord. It is, therefore, plain that the central cord indicating the formation of a water-bearing tissue in the leaf-mosses is in no way a sign of higher phylogenetic structure, but is wholly a mark of adaptation.

The mosses living in dry places form another biological group. Their stems possess either no or only very weakly developed central cords, which seem to have suffered degeneration. They are apparently the predecessors of the mosses of which we have just spoken as inhabiting moist situations, and which are furnished with typically constructed central cords. Mosses growing in water, likewise, for reasons easily to be understood, possess no or strongly degenerated central cords, and in this respect are analogous with submerged phanerogamous plants, in the leaves and stems of which the water-bearing system appears to have undergone a more or less extensive atrophy. Finally, those mosses in which an external circulation of water occurs are unprovided with a central cord, or present it in a very reduced form.

In the most highly developed mosses, the *Polytrichaceæ*, the central conducting bundle of the stem consists no longer of water-bearing tissues only; just as in the conducting bundles of the ferns and phanerogams, the vascular tissues for carrying plastic growth-food are combined with the water-ducts into a single system.

When we survey the different kinds of water-provision among the mosses, we are struck with the variety of ways of adaptation that have been developed for the attainment of the same end. In so small plants, the demands upon the efficiency of the water-bearing apparatus are likewise quite small, and the choice among them is only slightly limited. The larger the plant-forms become, the greater the demands made upon the water-bearing system, the more plainly appears the diversified efficiency of the adaptation henceforth possible, till at last there remains to Nature a single available model, which she applies with certain variations everywhere that large, stately plant-forms are produced.—*Translated for the Popular Science Monthly from Humboldt.*

INJURIOUS INFLUENCES OF CITY LIFE.

By WALTER B. PLATT, M. D., F. R. C. S. (Eng.).

WE do not intend to discuss in this paper the subjects of bad ventilation and impure air, imperfect drainage, damp cellars, or insufficient nourishment. Residents of the country may suffer from all these as well as dwellers in cities. There are, however, certain injurious influences more insidious in their operation, which are peculiar to cities, and affect the well-to-do as well as the poor, although not in equal degree. I believe these lead, sooner or later, to degeneration of the individual and his offspring, by producing progressive feebleness, and to ultimate extinction of such families as are long subjected to their force. I refer to those which chiefly affect the stability of the nervous system, rendering it less capable of sustained work, and, in a secondary way, only the circulation and general nutrition. The end-result of all these influences is to lessen the producing power of each man, and thus to depreciate his value as an economic factor. They ought not to exist if their removal be possible, and if it can be effected without greater expense than their ill effects warrant. Their cause is to be found in faulty municipal arrangements which can be largely corrected by intelligent action and supervision. They work by producing insomnia, aberrant forms of mental action, singling out those who are less strong as subjects of the so-called neurasthenia.

These effects accumulate with each successive generation subjected to their influence, until the final inheritor finds the load too heavy to bear and do any useful work. The ne'er-do-wells and idlers are often, not always, such, from actual inability for persistent effort. Let us see if such influences exist, if they are injurious

to any considerable extent, and if it is practicable to remove or modify them.

We refer chiefly to three, and these are: 1. Disuse of the upper extremities for any considerable muscular exertion. 2. The incessant noise of a large city. 3. Jarring of the brain and spinal cord by continual treading upon the stone and brick pavements which make our sidewalks and streets.

We leave out of the question those to whom these observations do not apply—viz., such as are able to spend nearly half the year out of town. Experience has shown that such individuals and families suffer in small degree from an ordinary city life; while, on the other hand, good authorities assert that there are very few families now living in London who, with their predecessors, have resided there continuously for three generations.

If there is one general physical difference between the country-bred and the city-bred man, it lies in the size and strength of the muscles of the shoulder and arm. It is almost impossible for a man to live in the country without using the arms far more than the average city man. This use of the arms has, in both men and women, an important bearing on the general health, since it increases the capacity of the chest, and thereby the surface of lung-tissue where the blood is spread out in thin-walled vessels through which the oxygen and carbonic acid easily pass in opposite directions, serving thus the double purpose of feeding the body more abundantly and of removing a constantly accumulating waste product.

This richer blood is again driven with greater force by increased heart and arterial action through its circuit. The vital organs are better nourished and the power to produce work is increased.

Few will deny that a well-nourished body can be trained to do more and better mental work than the same organism in a feebler state. Walking on an even surface, the only variety of physical exercise which most business and professional men get in town, is well known to be a poor substitute for arm-exertion. The reason is partially plain, since walking is almost automatic and involuntary. The walking mechanism is set in motion as we would turn an hour-glass, and requires little attention, much less volition and separate discharges of force from the brain-surface with each muscular contraction, as is the case with the great majority of *arm*-movements.

The arm-user is a higher animal than the leg-user. Arm-motions are more nearly associated with mental action than leg-movements. A man's lower limbs merely carry his higher centers to his food or work. The latter must be executed with his arms and hands.

A third way in which arm-exercise benefits the organism is

through the nervous system. Whether this is due to an increased supply of richer, purer blood, or whether the continual discharge of motor impulses in some way stores up another variety of force, we do not know. One thing is certain, the victim of neurasthenia is very seldom an individual who daily uses his arms for muscular work; with this, the limit of hurtful mental work is seldom reached.

It seems evident that arm rather than leg movements are essential to increased productive power. If these are neglected, the man as a social factor degenerates and falls a prey to his stronger fellow-man in the race for supremacy and productiveness. It may be remarked that American gout, that condition of the blood which causes our English cousins pain in their feet, and Americans universal pains and increased irritability, has one sovereign remedy so simple that few will take it, and this is daily systematic arm-exercise. It is Nature's sedative, for which she charges nothing the next day, but gives us sleep instead of insomnia, and cheerfulness in place of discontent. A man may walk in an hour four miles, on a city sidewalk, and reach his desk tired, exhausted of force, and better only for the open air and a slight increase of the circulation. Had he spent half that time in a well-ordered gymnasium, using chest and rowing-weights, and, after a sponge-bath, if he had gone by rapid transit to his office, he would have found his work of a very different color, easier to do, and taking less time to perform it. The view for some time held by Hartwell, of the Johns Hopkins University, Sargent, of Harvard, and others, that arm-exercise prevents or does away with nervous irritability, and at the same time increases the absolute capacity for mental work, has not been sufficiently urged or accepted.

The remedy for this state of things is to cause every man and woman to realize the importance of arm-exercise. Make it compulsory in schools, and popular after leaving school. If one's occupation does not require it in itself, muscular exertion of some kind ought to be taken daily, with the same regularity as food and sleep, for all three are necessary to the fullest development of our powers.

A second injurious influence, which pertains exclusively to city life, is incessant noise. This may not be very intense at any time, but, when continuous, it acts as certainly upon the nervous system as water falling upon a harder or softer stone. Recent experiments upon animals subjected to the sound of a continuously vibrating tuning-fork for a number of hours, one or two days in all, show that the first effect is that of an irritant to the nerve-centers, as certainly as an acid or an electric shock is to muscle-fiber. A secondary visible effect is opacity of the crystalline lens of the eye.

The noise of a city is at first painful and confusing to one unaccustomed to it. We do not maintain that a really bad effect is at once apparent upon most individuals. When people are subjected to such a variety of influences, it is difficult to isolate and measure the result of one. Not infrequently a change from a noisy to a quieter part of the town is most beneficial to especially sensitive individuals. Much noise is unnecessary to the performance of most useful work. It means waste, wear and tear in the majority of cases.

The most perfect are the most noiseless machines, and this applies to the social organism as well. The rattle of badly built wagons over poor pavements, the ringing of milkmen's bells, or the jangling of those on street-cars, street cries, and the like, have long been recognized as evils in European cities, and suppressed in many places. In certain streets in Berlin heavily laden carts and wagons are never allowed, and in others only when the horses walk. In Munich the street-cars have no bells. Recently in New York a measure has been under favorable consideration to abolish the ringing of milkmen's bells, and to have those on street-cars taken off. The immense relief to the residents of a street in Baltimore, where the cars run every three minutes in each direction, when the bells were omitted for several weeks on account of sickness in that street, will not soon be forgotten.

Every one will instinctively call to mind boiler-makers and workers in factories as instances where men work for years in incessant din without injury. These are instances like those of pearl-divers and miners, and show rather what can be endured by some than what is best for most. On the other hand, we have all known individuals in whom slight noises cause absolute pain. The blowing of locomotive and factory-whistles within city limits has been abolished in some of our largest municipalities. The loud ringing of church-bells at all hours of the day and night, in this age, when every one knows the hour of prayer, hardly recommends the religion of good-will to men. All these unnecessary noises add more weight to the overtaxed nervous systems of many men and women who can not escape them. It is certain that with the increasing intensity of city life, and its consequent strain, such things must be lessened, as far as compatible with business interests. Suitably enforced municipal regulations can do this. Elevated railroads should not be permitted in streets where men and women live, underground roads should take their place where it is possible. Certain streets, or blocks at least, should be reserved for business purposes, others for dwellings alone, and heavy wagons allowed only in the first named, unless they are to leave their freight in the block. Rattling irons and chains should not be allowed. Pavements should be thoroughly

laid and then kept in repair. Londoners find asphalt the best pavement for all but the very heaviest traffic, in spite of its being very slippery in wet weather. The advantages far outweigh this one disadvantage. Horses can draw much heavier loads than on Belgian block, with less noise, while they are the cleanest pavements known. Those called asphalt pavements in America are a poor imitation of what our English brethren enjoy. Intelligent, honest city government, in a word, will give us health as well as increased business facilities.

Jarring is an equally hurtful influence of city life that has not received the attention it deserves. Combined with the two preceding, it completes a formidable trio. Very few realize the fact that we who were designed to tread upon soft Mother Earth have become a race of dwellers upon rocks and stones. In walking, the jar of the fall of our one hundred and fifty pounds comes entirely upon the heel, since it first strikes the ground. The ball of the foot and the instep serve only to raise us for another downfall —small, it is true, but equal to the weight of our bodies falling through one half to one inch in a little less than one second. This shock would be sudden and unbearable but for the arrangement of the bones, muscles, and ligaments of the lower limb. The chief elastic distributing springs are the mass of muscles on the front of the thigh and that on the front of the leg. These deaden the shock much as two great India-rubber bands. The ankle and hip-joints help but little, while the curves of the spine and the disks of cartilage between the vertebræ aid a great deal in lessening the impact of the body with the ground.

This shock in ordinary walking is less than if the body be raised one half or three quarters of an inch on the toes, and then suddenly let fall upon the heels, since the limb which is put forward is somewhat like the spoke of a wheel, if we imagine a wheel consisting of an axle and spokes alone. The brain bears almost the same relation to its containing bony case, the skull, that the ball does to the cup, in the old-fashioned cup-and-ball, where the ball is tossed into the air and caught in its cup with a sharp shock.

If any one doubts that there is a distinct and decided *jar* of the brain with each step, let him walk a hundred yards when the brain is slightly over-sensitive from a bad cold or headache, and he will observe the pain each step causes. Or, more scientifically, let him place (as I did recently) a pedometer inside his hat, and it will register every time his heel strikes the ground.

Fortunately the brain, in health, does not perceive these slight jars to its own substance, and interpret them as pain. Nature provides one more anatomical precaution against jarring by slinging up the brain in its spherical hammock, the dura mater. Now, in many people, the ill effect of these thousands of slight daily con-

cussions accumulate, and after a time concur with other causes in producing that state of disability called nervous exhaustion. An observant man may see on one side of any stone or brick sidewalk in the city wherever there is soft ground near by, a well-worn path which will be instinctively chosen by pedestrians. If we test ourselves we shall find the chief reason of our choice is because it jars us less to walk there than upon stones and bricks.

Most healthy men endure these concussions for a long time without very serious effects, while others who suffer from them are entirely restored by enforced rest, provided the circulation be at the same time maintained. It is not improbable that some of the long cobweb-like processes of the nerve-cells are damaged by being shaken for months and years over city pavements.

Statistics upon such a matter are almost out of the question where insufficient exercise, noise, and jarring of the nerve-centers combine with other influences to overthrow the individual or to lessen his productive powers.

If it be then injurious to some to walk daily for years upon stones and bricks, and less so upon earth or softer material, this can be remedied in two ways. First, by changing the material of our sidewalks to a more elastic one. Something is needed for pedestrians which will be durable, yet not hard. Some of the varieties of asphalt composition are elastic, but none of them sufficiently durable, as far as I know.

Nature suggests a remedy in a second way, in the covering of the human heel itself where we find a very elastic pad one half an inch thick, to lessen the jar of walking. If we replace the perfectly hard boot-heel by an elastic India-rubber one, we provide an inexpensive and practical remedy, which it would cost the wearer but a few cents a month to keep in repair. This cover has the additional advantage of lessening the noise of hurrying feet, and preventing broken bones in the winter season. If now our city authorities will, at some future time, provide gymnasia as well as libraries and parks, make our large towns quiet as well as clean, and give us sidewalks more like Mother Earth, we believe such a favored community will produce more, and lead collectively a happier life, than most of our modern towns.

Arguments in behalf of Sunday observance, based upon grounds of religion or custom, or even upon the desire of certain classes of people to have one day of quiet, are not usually effective with those to whom they need to be addressed, for they care but little for these things. It may be a more potent argument that the conversion of Sunday into a day of pleasure is likely to injure those who work hard during the week, by forcing or tempting them to work on Sunday as well. There is no doubt as to the increase of Sunday labor during recent years, and it is very largely attributable to the increase of Sunday amusements.

SOMETHING ABOUT SNAKES.

By C. T. BUCKLAND, F. Z. S.

IN writing about snakes an apology must be offered for beginning with what may seem to be a boastful statement; but it is unavoidable, as it is my chief justification for putting pen to paper.

Therefore it must be avowed that, to the best of my knowledge and belief, the snakes have never had a worse enemy than they have found in me, and it came to pass in this way. In the year 1856–'57, being one of the secretaries to the Government of Bengal, I obtained the consent of the Lieutenant-Governor, Sir Frederick Halliday, to the issue of an order authorizing the payment of a reward of sixpence for every poisonous snake whose dead body should be produced before a district magistrate in Bengal. This was the beginning of the campaign against snakes in India, and my hand was responsible for it. It was subsequently backed up by the influence of Sir Joseph Fayrer, the greatest living authority on snakes. From that day forth, with occasional intermissions, the system of giving rewards has spread from province to province, until the total number of venomous snakes killed throughout British India in 1886 exceeded four hundred thousand. If it be admitted that, during the last thirty years, the average number of poisonous snakes killed has amounted to only one hundred thousand per annum, a child can calculate how many million snakes have to denounce me as the originator of the mischief and crusade against them.

Why, it may be asked, was such wrath against snakes kindled in me? The explanation is peculiar, and may not be the true one, but it happened that when I was a very small child, my mother's brother, the Rev. Matthew Arnold,* was bitten on the ankle by a viper at Slatwood's, in the Isle of Wight, and the story went that his life was in great danger, the whole of his body turning black gradually from the feet upward, until the blackness came as high as his heart, when it stopped and began to abate, until it gradually disappeared as the virulence of the poison wore out. This story made a grave impression on the juvenile minds of myself and my brothers. Not long afterward we were taken to stay with an aunt at Eaglehurst, in Hampshire, and somewhere down on the beach, toward Calshot Castle, I found a snake lying on the grass, which, being an "animosus infans," I picked up and brought to our nurse. Luckily for me the snake was dead, but according to the fashion of those days I was afterward soundly flogged, to teach me not to play with snakes again. From either of these

* Brother of Dr. Arnold.

causes it may have come to pass that an antipathy to snakes was engendered in my heart.

My cousin Frank Buckland, with whom I was for some time at school as a boy, had a fondness for keeping snakes in his pockets, which was not shared by his schoolfellows, including me. However this may have been, I have little recollection of anything about snakes at that time, except that when I was a boy at Eton there was a large snake exhibited one year at Windsor fair, which pleased our juvenile fancy, as we were glad to see a snake as described by Virgil *positis novus exuviis,* and we were delighted to buy, for a very fancy price, a piece of the old skin that it had shed. The next time that I met a snake the meeting was bad for the snake. A friend was driving me in his buggy in the suburbs of Calcutta with a fast-trotting horse, when a large snake tried to cross the road in front of us. But the horse, not seeing or not heeding it, trotted on, and a wheel of the buggy cut the snake in half. We pulled up to examine the remains, and it turned out to be only a large but harmless water-snake.

It is hardly credible how long a time a man may live in India without seeing snakes in his house, unless he looks about diligently for them. Of course there is more chance of seeing them out of doors, and especially out snipe-shooting, as the snake is an amphibious sort of creature, with a special appetite for a juicy young frog, whose home, not always a very happy one, is in the rice-fields. What with the long-legged birds of the crane species that stalk through the water, and the snakes who glide about in the mud, or lie on the little earthen ridges which divide the rice-fields for irrigation purposes, the frogs have a bad time of it. One afternoon I was walking along one of the earthen ridges between the rice-fields, looking for snipe on either side of me, when a few yards in front of me there reared up three cobras, facing me with hoods erect, and evidently "meaning venom." I fired a charge of snipe-shot into them, and there was a great confusion of heads and tails and bits of bodies, so that it would have been hard to put a whole snake together again. This gave me a useful lesson to keep a good lookout. One day I was out shooting with a friend who trod on a snake, which promptly curled round his leg and tried to bite through his gaiter. His gaiter was perfectly snake-proof, but he did not think of that, and his efforts to shoot the snake without hitting his own leg were so ludicrous that it was hardly possible not to laugh, until we could hit the snake on the head with a loading-rod and make it quit my friend's leg.

Once we were spending a holiday at a little bungalow at the seaside, to which we used to go occasionally for change of air, and sea-bathing if the tide permitted it. We were walking along the sandy beach, when we saw a large cobra, about five feet long, with

a bird in its mouth, making off through some light bushes, where it had probably seized the bird, though it had not had time to swallow it. We very soon disabled the snake by a blow on the back; but as it was by no means dead we secured it with a small rope, and dragged it into the portico of the bungalow for the sake of trying experiments with it. We sent for one of the numerous village dogs called pariahs, but the snake would not look at the dog. A fowl was then brought and placed with its legs tied, near the snake's head. The snake revived a little, and made a dart at the fowl, but the bird evaded it, and struggling to its feet it gave the cobra a fierce peck on the head, which quite decided the battle. The fact was that the snake was too much injured by the blow on the spine that had disabled it; and, moreover, it had probably spent its freshness and most deadly venom in killing the small bird which it had seized before we saw it. Many years afterward I saw a cobra bite a fowl, and turned to look at my watch to see how long it would be before the poison took effect. As I looked back again toward the fowl it fell down quite dead, within thirty seconds from the time it was bitten. This occurred in the house of a friend who had engaged an itinerant snake-charmer to exhibit snakes to a party of guests. Several cobras, deprived of their poisonous fangs, had been exhibited in the usual manner, when the snake-charmer stated that he had with him a snake of which the poisonous fangs were intact, and he offered to show it. He dealt with it very carefully with a forked stick in producing it from a basket, and he was equally cautious when he placed the fowl near enough to the snake to be bitten by it. What the result of the bite was to the fowl has been already told. There can be little doubt that if this cobra had managed to bite its keeper or any of the spectators, with its fangs fully charged with fresh venom, it would have been almost if not quite impossible to save their life.

It is always expedient in India to have a dog or a cat or a mungoose (a sort of ichneumon) about the house to keep away snakes, or to draw attention to them when they are crawling about. My wife's dog probably saved her life by barking at two snakes which had got into her dressing-room. A cat with kittens once drew my attention, by her extraordinary antics, to a large cobra, which she was trying to keep away from her young ones. The mungoose is the professional enemy of the snake, and goes for him at once to kill him, and perhaps to eat him. There is no valid foundation for the belief that the mungoose has recourse to an antidote to protect itself against a snake's venom. The mungoose relies on his own agility and sharp teeth, and on the coarse hair of his skin, which will avert most snake-bites. But if the snake gets well home, so as to lodge his poison in the mungoose's skin, that mungoose will surely die. It is not dissimilar to the case of the com-

mon village pigs in India, which are well known as scavengers and carrion-eaters. They will kill and eat any snake that comes in their way, and the hide of their hard and hairy bodies and legs is almost snake-proof. But if a cobra bites a pig on a soft place, so as to plant his poison under the skin, that pig will surely die.

The python, or boa constrictor, is comparatively common in Bengal, and sometimes grows to a great size. The first one that I saw was said to be twenty-four feet long, but it had been dead for several days, and the stench from it was longer than the street in which it was being exhibited to a crowd of admiring natives, and I could not venture to measure it. I saw another, which was said to be twenty-one feet long, being carried dead through the street of Dacca, but was unable to stop to measure it for myself. An officer, whose veracity I did not mistrust, told me he had found one in Cachar twenty-five feet long, which had committed suicide by swallowing a buck hog-deer, of which the horns injured and cut through the intestines of the snake before the gastric juices could soften the horns. There was a plentiful supply of pythons at the Zoölogical Gardens in Calcutta. One large one, which measured nearly eighteen feet, sat most patiently for more than a month over a batch of its eggs, and it was hoped that her perseverance and motherly affection would be rewarded by a young brood. But for some unknown reason the eggs were all addled. During her long incubation the mother snake was never seen to quit her eggs; and she would take no kind of food, although rats and chickens were offered to her from day to day.

It is not every one who has seen a python take a meal. It is usually averse to dead food; but it is very partial to a live rabbit or a chicken or a guinea-pig or by preference a rat. The python seems to know that the rat will try to escape, and he gives it no time or quarter. With a rapidity that can hardly be conceived, he seizes the rat with his mouth, and the fatal coil passes round the creature, squeezing all life out of it, and reducing the body to the form of an elongated sausage, which the snake lubricates with its own slime and swallows entire. If a fowl is put into a python's cage, the snake sometimes seems to take no notice, and the frightened bird, finding that no harm comes to it, begins to ruffle its feathers and to peck about, occasionally trying its beak on the snake's skin. But after a while the end of the python's tail may be seen to quiver with a strange emotion, while the small black beady eye is fixed upon the fowl. Suddenly there is a convulsion. The snake has moved and the fowl has disappeared, and can only be discovered by the end of a feather or two protruding from the coils in the python's neck which have crushed the bird's life out. In its natural state the python will catch a deer or a wild pig, and crush it in the powerful coils of its neck. There is a well-authen-

ticated story of a large python having caught two wild sucking-pigs simultaneously, crushing both with the same coil of its neck. In the case of the python mentioned above, which was killed by the horns of the buck that it had swallowed, the snake must have been able to break all the bones of the body, but the stag's horns were probably too sharp and pointed to be easily crushed, and the snake rashly took the chance of digesting them in its stomach. No stories of a python killing a man ever came to my knowledge, but one of the keepers at the Calcutta Zoölogical Gardens had his arm much injured one morning by a python coiling itself on it and squeezing it severely before the man could be rescued.

It has been mentioned that large rewards are paid throughout India for killing venomous snakes. The actual number of snakes for which rewards were paid in 1886 was 417,596, and the sum paid was 25,360 rupees, which is a little more than a penny each in the depreciated silver currency. These rewards are almost invariably paid, or ought to be paid, by the English magistrates themselves, after examining the dead snakes. Numerous attempts are made to pass off harmless snakes as poisonous snakes; and a highly educated native official will rarely condescend to allow a dead snake to come too closely between the wind and his nobility, to enable him to distinguish between the poisonous and the non-poisonous snakes. If the rewards were not paid by an English officer, a considerable portion of them would probably be intercepted by unscrupulous native subordinates before they reached the man who killed the snake.

When the Duke of Argyll was Secretary of State for India, he, as a student of natural history, took a special interest in the question of killing poisonous snakes. And there came to him one day at the India Office the cunning inventor of a machine called an asphyxiator, by which it was easily demonstrated that the snakes could be killed in large numbers in the holes in which they dwell in India. It was not difficult to show to his grace that when the asphyxiator was applied to a rabbit-hole the rabbit must either bolt or be suffocated. The snake would be treated in the same way as a rabbit. So the duke ordered some twenty asphyxiators, and sent them out to different parts of India. It happened that I was employed near Calcutta, and the Government of Bengal were pleased to order me to make a trial of the consignment of asphyxiators, which they regarded as so many white elephants. The asphyxiators were unpacked, and the instructions which accompanied them were read. There was a sort of fire-box in which a pestilently smelling paper was to be burned. There was a wheel to be turned, so as to send the smoke from the burning paper through a funnel into a long nozzle which was to be inserted into the snake's hole. This, it will be seen, required the services of two

men, one to keep up the fire and turn the wheel, and the other to direct and hold the nozzle-pipe. It was also requisite that a third man should stand by with a stick, to kill the snake bolting from its hole. We turned out with the apparatus properly manned, lighted the fire to get up smoke, and applied the nozzle to a hole in a bank near the stable, which was supposed to hold a snake. The smoke was injected, and out there bolted a terrified rat. The man with the stick struck at the rat and broke the nozzle-pipe. The man at the nozzle-pipe jumped back against the man who was turning the wheel, and in their fright they both tumbled down. The rat escaped, but if it had been a snake instead of a rat it is very probable that one of the three operators might have been bitten. The men lost confidence in the machine, and declined to work it. It was taken indoors, and put into an anteroom, where the native night-watchman usually took up his quarters. One cold night the watchman closed the doors of the room and lit a quantity of the medicated paper to warm himself. In the morning a well-asphyxiated watchman was found, but luckily he was brought round with deluges of cold water. This, however, was the end of the official career of the Duke of Argyll's snake-asphyxiator in Bengal.

Although most people have a natural aversion to snakes, and would on no account touch them, there are some persons who are accustomed to handle snakes (*tractare serpentes*), and will pick up a wild poisonous snake from the ground with impunity. George Borrow, the author of "The Gypsies in Spain," had this faculty; and I knew two officers, one of whom was a captain in a Scotch regiment, while his brother was the doctor, who said that this faculty of handling snakes had been born in them. In a work published not long ago by Mr. F. B. Simson, a retired Indian civilian, he gives the following prescription for catching cobras: "When you come upon your cobra, make him rear up and expand his hood. He generally does this quickly enough; but should he delay, whistle to him, imitating the snake-charmers. He will then certainly raise his head. Then with a small cane or stick, or the ramrod of a gun, gently press his head to the ground. The snake will not object; he seems rather to like it. When you press his head lightly to the ground with the stick in your left hand, you should seize the snake firmly with your right, close behind the head, holding his neck rather tightly; then let go the stick and catch hold of the tail. The snake is powerless, and you can do what you like with it. You should have an earthen pot brought and let the snake pass into it, as snakes will always go into any dark place." On the whole this prescription does not seem inviting. I have never tried it, and should hardly care to see any one try it.

Mr. Simson says that he had an elephant-driver, or *mahout*, who was a great snake-catcher and very reckless. He writes thus: "I never saw him press down the snake with a rod such as I have described, but he caught numbers of snakes of all sorts, and sent them alive to his house. His movements were so rapid, and generally in jungle and with his back to me, that I never made out exactly why he did not get bit. He used to jump off his elephant, leaving the animal in my guidance; in a moment afterward he had the snake's neck in his hand. He said that he caught them by their tails, swung them under his arm, and held them there, while he slipped his hand up to the back of the head. He then gave the snake some of his clothing to amuse himself with, and on which to expend its venom. He then wrapped the reptiles up in a loose cloth and took very little trouble with them. I have seen him catch snakes scores of times, but I rather discouraged him, as I did not like the idea of having live venomous snakes at large, or even in earthen pots or boxes. At the same time he received good prices for his snakes."

Some people who are used to handle snakes seem to lose all feeling of apprehension regarding them. Sir Joseph Fayrer, whose work styled "Thanatophidia" contains the most perfect colored plates and descriptions of the principal venomous snakes, had no fear of them. But he was very nearly bitten one day. He and a friend were busy examining the peculiar anatomy of a portion of a cobra's tail. The cobra was in a box, and a native assistant was supposed to be holding down the lid of the box so as to allow only the tail to protrude. Somehow the native became careless, and he relaxed his hold on the lid, so that the cobra suddenly put out its head to see what Sir Joseph Fayrer was doing with its tail. Luckily it was more pleased than offended at the liberties which were being taken with its tail, but it was unpleasant for Sir Joseph Fayrer to find his face almost touching the cobra's mouth. Dr. Richards was another officer who assisted Sir Joseph Fayrer in his experiments with snakes. Dr. Richards came one day to see a lady patient at my house. He arrived in a palanquin which was put down in the portico. He went to the lady's room and paid her a brief visit; and when he came out of the room he went to the palanquin and brought out a large cobra which he had brought over to show me, in order to prove by experiments in my presence that a particular kind of wood, which a native fakir declared to be an antidote to snake-poison, was of no value. It is unnecessary to recapitulate the experiments, but his familiarity with the deadly snake was quite alarming. I could not help wondering what his lady patient would have said if she had known that he had brought a snake with him to the house, for she was terribly nervous about snakes.

The snake-house in the Zoölogical Gardens in the Regent's Park is a most perfectly designed building for keeping the snakes in health, and for exhibiting them to the public. The late King of Oude had built a snakery in the gardens of his palace at Garden Reach, near Calcutta. It was an oblong pit about thirty feet long by twenty feet broad, the walls being about twelve feet high, and perfectly smooth, so that a snake could not climb up. In the center of the pit there was a large block of rough masonry, perforated so that it was as full of holes as a sponge. In this honeycombed block the snakes dwelt; and when the sun shone brightly they came out to bask or to feed. His majesty used to have live frogs put into the pit, and amused himself by seeing the hungry snakes catch the frogs. When a large snake catches a small frog, it is all over in an instant; but if a smallish snake catches a largish frog, so that he can not swallow it at once, the frog's cries are piteous to hear. Again and again I have heard them while out shooting, and have gone to the bush or tuft of grass from which the piercing cries came—sometimes in time, sometimes too late to save poor froggy, though the snake generally got shot. As a final story let me tell how a frog has been seen to turn the tables on the snake. Two gentlemen in Cachar some years ago saw a small snake seize a small frog and attempt to swallow it. But suddenly a large frog jumped forward, seized the snake's tail, and began to swallow the snake. How the affair might have ended can not be told, because my friends imprudently drew near to watch the combat, when the frogs and the snake took alarm, and the big frog disgorged the snake's tail, and the snake released the little frog, and they all scuttled off. But the tale is perfectly true, and both the gentlemen who saw it are still alive; and I only regret that it was not my good luck to see the affair with my own eyes.—*Longman's Magazine.*

AINU HOUSES AND THEIR FURNISHING.

By J. K. GOODRICH.

ON approaching an Ainu village one is deceived as to the number of houses, and apt to underestimate them. I fancy this is because of their being scattered about most irregularly, and because there are no streets to guide the eye. Along the coast the villages are, as a rule, built just inside of the first row of sand-dunes, which afford considerable protection from the heavy gales. Since the Japanese Government has undertaken the management and development of the Hokkaido, a good road leads through each village; but off on either side of this road the houses are built according to the fancy of the various occupants, and if a stranger

visits the village in summer, many of the outlying huts will be hidden among the tall, rank weeds, and by the growing vegetables. In every village which I visited I was constantly being surprised at the guides taking me off by some narrow foot-path in a direction where I had not suspected there was a house, and always we would find one or more.

The Ainu huts possess no claims to consideration from an architect. Their light frames have just strength enough to carry the thatch and resist the ordinary winds that blow from the ocean, on the shore of which most of the Ainu villages are built. We will consider a large house in which will be domiciled a family consisting of father, mother, and several well-grown sons and daughters. In building such a habitation the quadrilateral roof is first made. The ridge-pole and plates will probably be roughly hewed sticks of considerable size, in one piece if possible, though jointed if necessary. The girders and rafters are round sticks, lashed together and to the ridge-pole and plates with withes. No nails or tree-nails are used. Strong tie-beams support the plates, and when the roof is raised to its place, will carry shelves for stores, clothing, implements, etc. The thatch of the roof is laid on in courses of about eighteen inches in length, conforming to the length of the tall reeds and *arundinaria* of which it is made.

FIG. 1.—AINU HOUSES.*

The ridge is usually thicker and stronger than the rest of the roof, and is lashed by seizings at short intervals; the ends of the ridge-pole often project slightly, and small openings are left at either end under the ridge, which serve as smoke-holes. The roof is closely laid, turns water well, and has sufficient pitch to cause the melted snow to run off freely. Its strength is quite remarkable,

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

as the weight of snow, which often lies three and four feet deep, is considerable; while the force of the ocean-gales which speed in from the Pacific must subject it to very heavy strain. The eaves reach to within about four feet of the ground.

When the roof is quite finished it is raised by main strength and stupidity, and the corner posts, which are substantial sticks roughly squared, are placed in position. Then the wall-frames of smaller sticks, oftentimes with the bark left on, are lashed to the plates and to cross-pieces, to which are fastened the rushes of the wall. These are not laid on in a heavy thatch, as they are on the roof, but in one or two flat courses; very often they are so thin in places that it is possible to see between them. The median line of the house is always in an east and west direction. A sacred window is left in the middle of the eastern wall, through which the sun-god is worshiped, and before this an *inao* is placed. Another window, perhaps two, will be cut in the south wall just under the eaves. All the windows are closed by shutters opening outward and swinging from the top, being caught up and held by a lanyard secured to the eaves on the outside.

In the house which we are describing there will be an addition on the west of about fifteen feet square, but much lower than the main building. The roof of this is also made first, raised to its proper position, and the thatch joined to that of the main house. This roof slopes toward the north, west, and south. The walls are the same as those of the main building, the entrance-door being in the southern wall and protected by a small porch with thatch roof and rush walls; opposite the entrance-door a small window is cut in the north wall, and beneath it is placed a rude sink for culinary purposes. As the occupations of the inmates do not require much light, the windows are quite sufficient, while ample ventilation is secured through them and the thin walls. There are no partitions inside the hut, though the western extension is sometimes separated from the main room by a light wicker framework, about three feet high, with openings at the sides of the fireplace, which is always directly under the ridge-pole, but rather nearer the western end. The fireplace is oblong in shape, the ashes being kept at about the level of the floor on either side. Sometimes the whole floor of the main apartment is boarded over on the north, east, and south sides of the fireplace, but usually this flooring only extends along the eastern end under the sacred window, the entrance-door always being in the western end of the single building, or in the southern wall of the western extension. The northern side of the fireplace is sacred to the family, a small sleeping-box being usually built under the eaves; the head of the house, or eastern end, is reserved for permanent or distinguished visitors, and the southern side is for occasional callers.

With the house built and the family in possession, let us enter and see how they conduct themselves, and how they arrange their various goods and belongings. And, in order to make the picture more real, I will describe some houses which I actually visited in the village of Horobetsu, province of Iburi, on the east coast of the island of Yezo. Passing through the porch of the first house into the western extension or vestibule, we found a medley of articles hanging from the beams and pegs in the walls or resting on shelves hanging from the cross-beams, or tossed into the corners and lying on the earthen floor. There were pack-saddles, bundles of grain and hemp, some strips of smoked fish, clothing (old and new), fishing and hunting implements, and apparently a thousand and one useful and useless things scattered about in the wildest confusion. This room was evidently the workshop, and two old women were busily occupied, nor did our entrance in the least disconcert them; for, after giving us a pleasant greeting and a laughing permission to examine everything, and to write and sketch as much as we pleased, they went on with their work—nor did they stop from time to time to see what we were about and to talk about the foreigner, as I am sure Japanese peasant-women would have done under similar circumstances. One of those women was cutting off the heads of a lot of barley with an old knife, preparatory to thrashing, and preserving the straw for future use in making rough mats; the other was washing a lot of potatoes that had evidently been torn from the earth all too soon, or else they were of the kind known as "small potatoes and few in the hill." This one had apparently left her weaving to care for the potatoes, as a mat-loom was lying on the ground near her.

Between this vestibule and the main room the wall had been cut away (probably had never been built), and a light, open wicket fence made of rushes, about three feet high, thrown across the dividing line, with openings on the north and south sides giving entrance to the living-room. Passing through the southern entrance we found that the fireplace was surrounded on the west, north, and south sides by a narrow passage-way, the floor of which was the ground itself. This was backed up by a narrow shelf on the north and south, but on the east the raised dais came up flush with the rim of the fireplace.

The south side of the house is devoted to the younger members of the family and to occasional visitors. Close to the wall were some small boxes containing the private belongings of some of the girls. Strange to say, these boxes, although without locks or fastenings of any kind, are considered inviolable by the men, and no one ventures to open them save the owner. Even if the master himself knows that they contain the much-coveted *saké*, to

get which an Ainu man will resort to any expedient, or contain ready money with which he might purchase the one thing essential to perfect happiness according to his light, he does not dare to violate their sanctity.

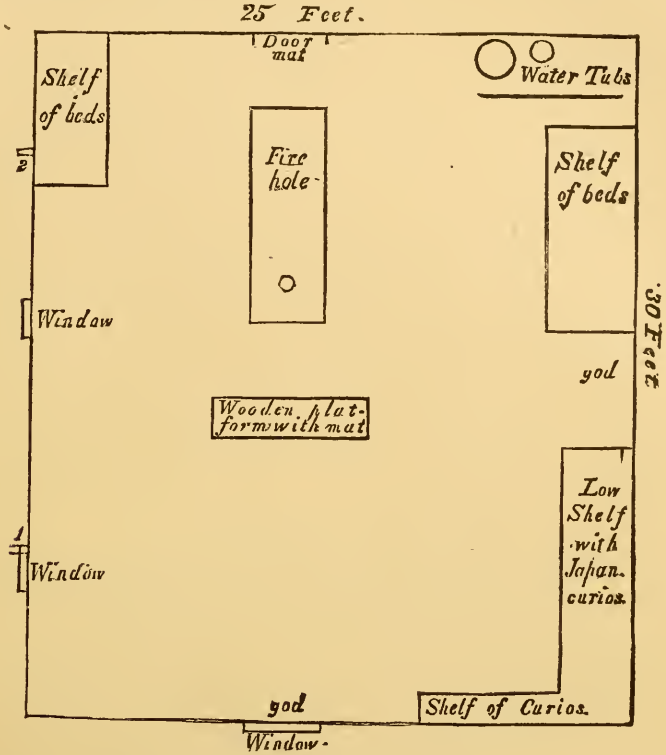


FIG. 2.—PLAN OF AN AINU HOUSE.

Back of the eastern dais, along the wall under the sacred window, were hung some very pretty mats with a curious, semi-geometrical pattern picked out in brown and red. These served as a background for one or two sets of open shelves, on which were arranged a number of cups, plates, and other pieces of crockery for every-day use. These were all of Japanese manufacture, and had evidently been brought from the main island, for the Ainu do not make pottery of any kind; nor is there any authentic record of their ever having done so, though they have a myth that in ancient times they possessed the art, but that all specimens were destroyed, and the written instructions for making ware were stolen from them. It may be remarked, parenthetically, that this is entirely discredited by those who know most about Ainu ethnology.

In the northeastern corner of the house—which, next to the eastern window, is held sacred—on shelves, some of them covered

with mats, were a number of Japanese household utensils in lacquer, carved wood, earthenware, and brass. Many of these were very old and excellent specimens of art, and some bore the crests of Daimiyo (feudal lords of Japan), showing that they had very likely been received as presents from their former owners.*

There were food-boxes, clothing-boxes, and clothes-frames (clothes-horses), bowls for food and saké, rests for swords, urns or tea-chests, about two feet high on four small legs, tubs for saké of the same height; all ranged in order, rarely used, and not to be bought unless for fabulous prices. Hanging from a beam in front of the corner, transformed into an open cupboard, were four swords, a matchlock, a bow with accompanying quiver full of arrows, and a pair of winter half-boots, made of salmon-skin. The swords were similar to the Japanese in most particulars, though not quite so long, nor so well made, and certainly not as well cared for as a Japanese sword would be; the handles were of wood, rudely carved and ornamented with little studs of brass or tin, secured by short nails, and tiny bells; the guards were just the same as those of Japanese swords; the scabbards were of wood, in two pieces neatly joined. The swords are worn on the left side, well up under the arm, and hang by a broad strap which passes over the right shoulder.

Passing along the north wall of the house, we came to the sleeping-box, as I must call it, for it can not be designated a room. It was tucked well under the eaves, was about ten feet long by eight wide, and raised eighteen inches above the floor of the house. One end of it formed the side of the curio corner just described. On the floor was spread a piece of matting, and the *futons*, or heavily wadded cotton quilts, on which and under which the family sleep at night, were neatly folded and laid in a pile on one side; the pillows in this house were of the Japanese pattern, little stands that support the neck, and which look to be wretchedly uncomfortable, but which are not so very bad when one gets accustomed to them. At night, or whenever any one is sleeping, a mat curtain is hung up in front of the sleeping-quarters, thus sealing up the inmates almost hermetically. I can not imagine any greater misery than to be compelled to be one of

* Miss Bird says: "Some of these things were doubtless gifts to their fathers when they went to pay tribute to the representative of the Shôgun and the Prince of Matsumae, soon after the conquest of Yezo. Others were probably gifts of *samurai*, who took refuge here during the rebellion, and some must have been obtained by barter. They are the one possession which they will not barter for saké, and are only parted with in payment of fines at the command of a chief, or as the dower of a girl." At the close of the rebellion of 1868, one last stand was made by the Tokugawa adherents in Yezo. The Ainu were noncombatants, and doubtless had many opportunities of befriending the unfortunate ones, who showed their appreciation of Ainu kindness and hospitality by leaving some of their belongings.

half a dozen to occupy that miserable little box at night, deprived of all fresh air save the little that might strain through the reeds of the house wall, for "freshness" can not be applied to the air from the interior of the house itself, that must reek with the stench of rancid oil, half-cured fish, smoke, etc., and, as for fleas and insects not usually mentioned in polite society, let us draw the curtain!

We have now passed quite round the hut and reached the entrance on the north side of the wicket fence. In this corner were the spare clothes, rough-weather garments, and private boxes of the master and mistress.

An iron kettle was hanging from a crane over the fireplace, and strips of sword-fish and salmon-flesh were curing on a frame suspended over the fire, the smoke being increased by burning green wood and leaves. The effect of this pungent, stinging smoke was very trying to eyes and lungs, and compelled me to cut my visit and minute description rather shorter than I would have wished.

Various fishing and hunting implements and miscellaneous odds and ends were placed on the cross-beams, or on shelves

FIG. 3.—AINU AT HOME. (From a Japanese sketch.)

resting upon them, just as will be seen in farmers' and peasants' houses the world over. Though hunting and fishing are essentially the occupations of the men, and the women's assistance is only called in to perform the drudgery of cleaning, salting, and curing the fish and dressing and cooking the bear's meat, still the women

are tacitly permitted to go fishing by themselves on moonlight nights, when they use the spear and nets almost as dexterously as the men.

There was no ceiling of any kind, and the inner side of the thatch, the beams, girders, etc., were black with smoke and glistening with oil and grease. When foreign guests remain overnight, a temporary room is set off for them at the eastern end by spreading a mat over the beams and hanging others therefrom.

There was nothing resembling a chair in the remotest degree; the men sit in true Turkish fashion, and the women either rest in that way or squat upon their heels like the Japanese. The nearest approach to a table was the small *zen* upon which the dishes of food are placed, an independent zen for each person, but these are not often used by the Ainu. At meals each person's bowl is filled from the pot by the mistress and handed to him, and, as their dishes are generally stews containing a little of everything in one grand mess, a series of bowls or dishes for a variety of courses is not necessary. Of wall ornaments, such as pictures and *kakemono* (the favorite hanging scroll picture of the Japanese), there was nothing at all.

This is rather a superficial description of an Ainu hut. Not the slightest attempt at architectural ornamentation was anywhere visible, the single idea seemingly being to provide a slight protection from the worst of the weather.

At a short distance from each hut is a small storehouse, raised on a framework about five feet from the ground. In construction this is quite the same as the house itself, the walls sloping inward slightly for the sake of strength. The door is at one end, and is reached by a ladder or a notched stick. It was a delightful comment upon the character of the Ainu to note that none of these storehouses were locked or fastened in any way against thieves. They contain the spare food, the unthrashed grain, etc. I should think, however, that some sort of locks would be necessary now that the population of the villages is becoming more and more mixed each year, for the average Japanese's ideas of *meum* and *tuum* are apt to be somewhat vague.

Another hut which I visited, and where I made a much longer stay, was not so large as the first, having no western extension. It was more modern in its appointments, being floored over entirely, excepting a small space just inside the western door, where visitors put off their sandals or shoes. We were fortunate in finding some men here, and the master took great pride and apparently much pleasure in displaying his treasures, but he refused to be at all communicative as to their history. He, too, possessed many choice bits of old lacquer, and many Japanese curios, which he said had been given to his ancestors. More than that he would

not say, and I finally concluded that he could not. All of the men and some of the women wore large brass ear-rings. There was one woman with a roguish, gypsy face, that strongly confirmed Miss Bird's comparison of these people to the inhabitants of southern Spain. Her peculiarity of speech in the matter of final *a* and *e* was so marked as to induce a smile, and, as soon as she detected it, she was so much disconcerted that she would say

FIG. 4.—AINU STOREHOUSE.

nothing more. I was sorry for this, as her voice was truly musical, and I know she was sorry also, because, being the mistress of the house, she was itching to have a word in the bargaining that ensued. This house was comparatively clean, and, when mats had been spread for us at the eastern end, we were quite contented to remain for a long time.

At first, the master of the house pretended to be very reluctant to sell any of his possessions, but, after much persuasion, he at last consented to let us have a sword, a bow and arrows, and a lot of small things which we still keep as souvenirs. Then, when the others found that trading *for money* had commenced, they went off for things, and soon we were overwhelmed with bargains. Evidently the Ainu have advanced in foreign civilization, in one respect at any rate; for, instead of evincing any disinclination to take money for the articles we wanted, they at first asked exorbitant prices, over which we did considerable haggling before agree-

ing upon a sum that was very high for them, but fairly reasonable for us.

In a third house half a dozen women were cutting up swordfish and preparing strips for smoking, by stretching them with pieces of stick into a regular V-diamond pattern. Several men sat round smoking and giving orders, but loftily refusing to do anything to assist their wives. The men apologized for the dirty appearance of the place, and truly an apology was in order, for a dirtier, more malodorous house I never entered! They said we would not care to sit down, nor did we. A hasty glance was enough to show us that, in all essentials, this was quite similar to the others.

I paid a visit to the village chief, who lives in a large house, a part of which is occupied by a Japanese Christian, who is trying to do missionary work among the people. The chief, a very old man, received me sitting in front of his cabinet of Japanese curios. He bowed, extended both his hands with the palms up, waved them toward himself, and stroked his long gray beard. These actions were repeated twice, and were accompanied by a low, murmured greeting, which was translated to me as meaning that he deemed himself highly honored by my call, and hoped I would enjoy myself during my stay in his village. The Ainu, he said, were too poor and too ignorant of the manners of honorable foreigners to do anything to entertain me; and a lot of compliments and pleasant things. His quiet dignity of manner, and his low, musical voice impressed me very favorably; and, although he was dirty and clad in rags, he looked the chief.

Fig. 5.—Ainu Patriarch.

One of my guides brought something in his hand and asked, in rather a mysterious way, if I wished to see an Ainu musical

instrument. Of course I said that I did, when, to my great astonishment, he produced an iron Jew's-harp of orthodox pattern, and to my utter astonishment told me that it was an original Ainu invention! Aside from the fact that it evinced a degree of skill in metal-working to which the Ainu have never attained, its whole appearance betrayed it at once. It is true that they have a musical instrument, of which Miss Bird writes: "They have another which is believed to be peculiar to themselves, consisting of a thin piece of wood, about five inches long and two and a half inches broad, with a pointed wooden tongue, about two lines in breadth and sixteen in length, fixed in the middle, and grooved on three sides. The wood is held before the mouth, and the tongue is set in motion by the vibration of the breath in singing. Its sound, though less penetrating, is as discordant as that of a Jew's-harp, which it somewhat resembles." I did not see one of these wooden instruments, but that which they showed me was so unmistakably of foreign manufacture that I could not suppress a smile when the extraordinary claim was made, and thereby hurt the feelings of the sensitive Ainu. This claiming priority in inventing the Jew's-harp quite jumps with their assertion that their progenitors used tobacco (though the dates of the introduction of tobacco to China and thence to Japan are quite well known, and it is beyond question that the Ainu learned of tobacco *and how to use it* from the Japanese); that they used to have a written literature, all traces of which were stolen by Yoshitsune; and other minor but equally untenable claims.

The only Ainu weapons which show any individuality are the bows and arrows. Their knives, swords, spears, and matchlocks are clearly of Japanese make. They have discarded flint and stone arrow-heads and spear-points, but only a comparatively short time ago; specimens in obsidian, etc., can be dug up in the vicinity of most of their villages.

The Ainu bow is made of a light, rather coarse-grained wood, resembling red cedar in appearance. This wood is called *on-ko*; in Japanese, probably, *araragi*, (*Taxus cuspidata*); the Chinese character which the Japanese employ for this wood seems to refer to the *Ailanthus glandulosa* by the synonyms, but may also denote a kind of *Rhus* (*Rhus cotinus*). Batchelor says that the *on-ko* is the yew-tree. It is very inelastic, and, unless a singularly good piece can be obtained, the bow is wrapped with thin strips of wild cherry to increase its elasticity—just as the Esquimaux seize their bows and brace them with intestines. I examined a great many bows, but did not see any "stout saplings with the bark on," as mentioned by Miss Bird, and I am inclined to think that she may have mistaken the cherry-seizing for bark. The bows are short, the longest I saw being only fifty-three inches, the

shortest not over thirty-six inches. They are all roughly dressed to a round shape, and are quite devoid of ornamentation.

Miss Bird's description of their poison-arrows is so exact that I take the liberty of transcribing it entire: "The arrows are very peculiar, and are made in three pieces, the point consisting of a sharpened piece of bone with an elongated cavity on one side for the reception of the poison. The point or head is very slightly fastened by a lashing of bark to a fusiform piece of bone about four inches long, which is in turn lashed to a [reed] shaft about fourteen inches long, the other end of which is sometimes [usually] equipped with a triple feather, and sometimes is not. The poison is placed in the enlongated cavity in the head in a very soft state, and hardens afterward. In some of the arrow-heads, fully half a teaspoonful of the paste is inserted. From the nature of the very slight lashings which attach the arrow-head to the shaft, it constantly remains fixed in the slight wound that it makes, while the shaft falls off."

The exact composition of this poison is not known, I believe, but aconite (*Aconitum Japonicum*, a monkshood) is doubtless the principal ingredient. The Ainu claim, that a single wound kills a bear in ten minutes, seems to be well grounded, although few foreigners have ever accompanied them on their bear-hunts. They allege that the flesh is not rendered unfit for eating, though they take the precaution of cutting away a considerable quantity of it round the wound as soon as they can get at the bear.

In using the bow, it is held upright, grasped near the middle by the left hand, and held as nearly as possible at arm's length. The string and nock of the arrow are caught between the thumb and first inner joint of the forefinger of the right hand. The arrow is passed on the *right-hand* side of the bow and between the first and second fingers of the left hand. The pull is made toward the right ear, as in Western archery, but, owing to the stiffness of the bow and the shortness of the arrow, it is not a very long pull. That is not necessary, however, for the bow is only used at close quarters, when the aim need not be very accurate. The string was formerly made of attush, but they now use hemp or hard-twisted cotton.

ATTENTION is now directed to the provision for recreation and exercise in girls' schools. While a great improvement has been realized in the matter, it is still in most schools quite insufficient. The usual provision for calisthenics, light games, and geological and botanical walks, is only held to be good as far as it goes. It can not pretend to contribute to the making of sound women in the sense in which the perfect freedom of activity given to boys tends to make them sound men. Perhaps notions of the degree of physical freedom it is proper to allow girls at school are at fault.

TEACHING PHYSIOLOGY IN THE PUBLIC SCHOOLS.

By A TEACHER.

IT will not be amiss at this time, when many of the States have decided that "physiology and hygiene, with special reference to the effects on the human system of alcoholic stimulants and narcotics," must be taught in their public schools, to glance at the reasons for such teaching, at some of the books and methods in use, at some of the results already obtained, and at what might reasonably be expected to result from proper teaching and proper study.

Those who study the causes of infant mortality, especially in large cities, of intemperance among the laboring-classes, of the crimes which thrive in the hot-bed of tenement-house life, of the increase of nervous disorders and insanity in this country, can not but see that dissipation (using the term in a general sense) and a disregard of the requirements of health are responsible in a large measure for the evils named, as well as for others which afflict mainly the so-called higher classes of society. The fact that much of the dissipation and the disregard of health laws is due to ignorance rather than to want of thought is sufficient reason for the study of health laws. But, as the health of individuals is closely related to the health of the village, town, or city in which they live, and as "public health is public wealth," another reason is apparent for the popular study of hygiene. Says Dr. H. P. Yeomans, of the Provincial Board of Health, Ontario, Canada: "Practical experience has demonstrated that the work of educating the people in all that pertains to public hygiene is a most important factor in the successful accomplishment of our objects as sanitarians. At every step in our legislative halls with local health authorities, in communities, and in our experience with individual citizens, we encounter more or less opposition arising from a lack of intelligent comprehension of the causes of disease, the best method of preventing the spread of epidemics, and generally of the preservation of public health. . . . It is a well-recognized principle, especially in a free country, where the sovereign power is lodged in the body of the people, that popular sentiment must proceed in advance of legislation in order that the successful enforcement of law may be secured."

The instruction of the adult population in health matters must be, in the main, through the current literature of the day and by popular lectures. The children who are to be the future molders of the country's welfare should be systematically and properly taught in the schools physiology and hygiene, with only enough anatomy as a foundation for the study of physiology.

If Dr. Hammond's statement be correct that many school children of the present day are oppressed mentally and physically by too many and too hard studies, it is imperative that parents, teachers, and even pupils should know what work the child's brain and body can and ought to bear. But this statement of Dr. Hammond will cause the introduction of the studies of physiology and hygiene to be objected to by some on the ground that any additional studies will weigh too heavily upon the children. This objection is a valid one if the prescribed lessons are to be merely memorized by pupils, and if the children are to be rigorously marked for not remembering. Improperly taught, as these subjects too frequently are, they become distasteful to the pupil, discouraging to the teacher, and are calculated to do more harm than good. Properly taught, they will not be merely additional studies for the pupil to grind out with tears and labor and vexation of spirit, but will be welcomed because they lighten the work imposed by the routine of school-life.

Until very recently, in order to obey the precept, "Know thyself," the teaching has been almost altogether anatomical, dry descriptions of the position, shape, and use of bones, muscles, and the various tissues of the body. Unfortunately, much of this sort of teaching still prevails, even for young children, and some of the books in use foster such teaching. Fortunately, many of the books devote more space to physiology than to anatomy, but a few only give much attention to hygiene, which is the most practical of the three studies, but its study should be associated with that of the other two.

Says Dr. Parkes, the eminent sanitarian: "Hygiene aims at rendering growth more perfect, decay less rapid, life more vigorous, and death more remote." Information that will help to effect these ends is what is needed by all who wish to enjoy and accomplish most during life. While it is of interest to know what bones are, and how many there are in the body, where the location of the heart is, and what are its functions, it is of more practical importance for all of us to know what will keep the bones in sound condition, and what we should or should not do in order that our hearts may serve us faithfully many years. The practice of hygienic laws, as well as the study of hygiene, is needed both in and out of schools much more than mere anatomical and physiological knowledge. Dr. Stephen Smith, as President of the American Public Health Association, voiced the opinion of many sanitarians when, in 1873, in an address before the association, he said: "Were a well-digested system of education in hygienic matters, which so vitally concern the well-being of every person, adopted and put in practice with anything like the vigor with which we insist upon the study of the common and useful branches, like

geography, arithmetic, and grammar, and the uncommon or ornamental branches, as French, music, etc., within one generation the whole mass of the people would be so enlightened on subjects relating to the hygiene of every-day life that our average longevity would be immeasurably increased." Not only would life be prolonged, but better mental and physical work would be accomplished by the prevalence of health, which to many a worker is more than half the battle, and the poor quality of which holds many an earnest soul down in the toils of poverty and despair.

Since Dr. Smith's address was delivered, efforts have been made to systematically teach in the schools the principles of physiology and hygiene, but the results have not been as good as we had a right to expect. This has been owing to the character of many of the text-books in use, to the short time allotted to the study of physiology and hygiene in the schools, to the unsatisfactory education of the teachers in hygienic matters, to the undue teaching of anatomical details and the use of hard technical terms, and, finally, to the preponderance of so-called temperance teaching to the exclusion of other and weightier matters.

We can not coincide with the view of the distinguished editor of the "Sanitarian," as set forth in an editorial, June, 1877, that "with such a multiplicity of studies the teacher *never* (italics ours) goes beyond the text-book." But we do agree as to much that follows. He says: "The pupil learns that muscles are not bones, that the liver is a gland, and that the heart is a muscular organ, that the food in some way or other is turned into blood. Beyond this there lies a nebulous mass of learned names, barbarously pronounced and ignorantly applied, which the first contact with the world dissipates, as a summer sun does the mist of the morning. . . . The text-books . . . are mere table-books and catalogues of names, or else their familiar style is so gelatinous that the student is unconscious of swallowing anything. One author treats the subject from a chemical standpoint, another from an anatomical standpoint, while the third combines the two with an unprofitable result."

The following extracts from some of the books now in use in the schools indicate how anatomy, physiology, and hygiene are being taught in certain quarters, for there are many teachers who *will not* know anything in regard to any subject outside of the text-book used by them:

One book says in its preface: "Technical terms have been avoided, and only such facts of physiology developed as are necessary to the treatment of the effects of alcohol, tobacco, opium, and other truths of hygiene." A careful perusal of this book will show that the physiological facts developed have little or nothing to do with the *treatment* of the effects of alcohol, tobacco, etc.

Much is said in the book as to what the effects are, but nothing as to the treatment of these effects. And why should there be? Such information should be confined to medical works. On one of the pages of this book is the following: "Children's bones have more gristle than those of older people; so children's bones bend easily. I know a lady who has one leg shorter than the other. This makes her lame, and she has to wear a boot with iron supports three or four inches high in order to walk at all. One day she told me how she became lame. 'I remember,' she said, 'when I was between three and four years old, sitting one day in my high-chair at the table, and twisting one foot under the little step of the chair. The next morning I felt lame, but nobody could tell what was the matter. At last the doctors found out that the trouble all came from that twist. It had gone too far to be cured.'"

The writer of this account would have the reader believe that the hip-joint disease which the lady had, and which caused the shortening of three or four inches in one leg, resulted because there is more gristle in the bones of children than in those of adults, and because on *one* occasion a child between the ages of three and four years twisted its foot under the little step of a high-chair. This twisting, it is presumed, injured the gristle somewhere in the leg, and so caused deformity. How many little children are there who do not twist their feet under the little steps, as they sit in their high-chairs? In how few does hip-joint disease result. If a child runs the risk of such an affliction every time the foot is twisted under the little step, then the children of nowadays are puny folk. The truth is, such a result is rare, if it ever happens with a healthy child. Still, if a child can be taught to sit straight in its chair, with feet on a level and side by side, well and good. Most physicians, I take it, would be apt to say in regard to this reported case of deformity: "If such a result followed such a twisting, in all probability the child was not strong and healthy, but of a rachitic or rickety tendency. In such children the bones and ligaments are *unusually* soft and quite easily bend out of shape."

On another page of this book is a pretty picture of a mill, which the text tells us is a snuff-mill. The writer says that after entering the mill "the smell of the tobacco was so strong that I had to go to the door many times for a breath of pure air. I asked the man if it did not make him sick to work there. He said: 'It made me very sick for the first few weeks. Then I began to get used to it, and now I don't mind it.'" Then the writer adds: "He was like the boys who try to learn to smoke. It almost always make them sick at first; but they think it will be manly to keep on. At last they get used to it." Who will say that the

average boy will not try to get used to tobacco after being told that he can do so if he will ?

The book dwells, wherever there is a chance, upon the evils of alcoholic drinks, but gives, in all earnest, the following bill of fare as suitable for the dinner of a child : "Roast beef, potatoes, squash, bread, butter, salt, water, peaches, bananas, oranges, grapes," but no where is there any advice as to how much of these things should be eaten at one meal. Intemperate *eating* is considered a matter of small account.

In one place is the following saying : "A good cook has more to do with the health of the family than a good doctor." It might, perhaps, have been well for the writer to quote this saying if it said, "poor doctor" or "many a doctor." A good cook is surely a blessing, but there are good cooks and good cooks as the opinions of different families go, and, while food that has been cooked by a "good" cook may taste well, it may not digest well. Good doctors at the present time not only know what good cooking is, but are able to choose digestible food as well. The above motto is a fair specimen of the sayings which are recklessly put into text-books.

A second book in use states in its preface as one of the reasons why the book should appeal to teachers, "The adaptation of the text to oral instruction, *the teacher's work being already arranged.*" The italics were used to emphasize the fact that the teacher's work has been made easy, and that no particular effort on his or her part will be necessary. This book, with about two hundred and twenty-five pages of text, devotes thirty-seven pages to bones, giving numbers and names in detail, while three and a half pages only are devoted to the subject of food, and twelve to digestion. The front and rear views of the normal skeleton depicted in the book are pictures of deformed skeletons, with lateral curvature of the spine and ill-shaped skulls. An accurate picture for a school-book is evidently not a matter of importance.

This book has pictured, as do other text-books, to magnify the evils of tight-lacing, the skeleton of a well-formed chest with an outline of the body and the skeleton of a contracted (corset-laced) chest with no such outline. The outline in the one case gives the appearance of much expansion, and the absence of it in the other exaggerates the contraction. This method of representation is considered by reliable artists as tricky, and was pointed out to me by an excellent lady teacher of physiology and hygiene, as an unfair way of showing the evil effects of tight-lacing.

A third book, intended for the use of primary schools, is made up of questions and answers ; nothing left for the teacher to evolve, nothing for the pupil to imagine or solve. Both teacher and pupil are machines to grind out so much material in an al-

lotted time. Five or more pages of this small book are devoted to bones, especially the location and number, but nothing is said as to what is necessary to keep bones in good condition.

The subject of alcohol is fully treated of, but intemperate eating, exercise, sleep, bathing, etc., are not even referred to. We doubt whether pupils who use this book could answer correctly if questions upon the various subjects were put to them in a different way from those they have been accustomed to.

A fourth book endeavors to teach the truths of anatomy, physiology, and hygiene in an allegory. The preface presumptuously compares the allegorical teaching of the book with the parables of Christ, and says: "If the great truths of Christianity could be taught in allegory, may not less difficult subjects in the same manner be made interesting and instructive." The preface further states that the authors have "shun abstruse and technical phraseology," have aimed "to give correct and scientific views in simple language with correct illustrations."

On looking over this book, we notice many poor pictures and the fact that a number of the pictures, though lettered, have nothing about them to indicate what the letters stand for. It is noticeable, also, that technical and abstruse terms are not infrequent, such, for example, as "perimysium," "quadrangular papillary clumps," "sebiparous glands," "germs of absorbent vesicles," etc. A third feature of this book are the attempts to be facetious. For the most part these attempts are ridiculous and out of place in a school text-book.

A fifth book, which has a large sale and is in the main excellent, has at times evidences of careless teaching; for example, "When milk produces an unpleasant effect upon the stomach, it should be mixed with a *little* lime-water." Italics are ours. In the list of antidotes for poison from fish-eating, appears the following: "Ether with a *few* drops of laudanum mixed with sugar and water may afterward be taken freely." Again italics are ours. In the use of mustard as an emetic not a word is said as to the importance of mixing it thoroughly with the water used, lest suspended in mass it may inflame or irritate the stomach.

We may judge somewhat of how a study is in general taught by the oral or written answers given by a number of pupils, in various schools, in reply to questions upon the study. About a year ago there appeared in the London "Architect" the following: "If instruction in sanitary matters is to be continued in schools it will be necessary to supplement the lessons with visits to some such place as the Parkes Museum of Hygiene, unless the school boards are satisfied if the children get hold of a lot of hard words, or rather of sounds resembling them. At present it is supposed that sanitary science may be taught as easily as morality,

by listening to a teacher read from a book. The children fail to catch the words, or they attach no meaning to them. Here, for example, are verbatim copies of the exercises in one of the Greenwich schools:

"'Infections are brought on by bad smells, such as small-pox, measles, scarlet-fever, glass-pox, s. c., they are brought on by bad drainerges suers; they must be well ventalated. Infection disease are caught by touching such as charcoal, chloride of lime, etc. Measles, feaver are called disinfectionous because they are catching.—Fainted. If a person as fainted, take her out in the open air lay her down with her head. And do the clothing round the neck and dashed cold water the face and hand and put smelling salts to her nose. Degestion is paines in the head, paines in the stom-ach, bad tempers. From degestion comes consumption, information, head-ache, neuralgia.'

"These exercises may be thought amusing, but it should be borne in mind that every word represents more or less pain to some unhappy child, in endeavoring to recall ponderous words which were without meaning. Education in sanitary matters is desirable, but, as it is conducted at present in public schools, it must injure children's minds by habituating them to the use of words which they can not understand."

In the English official reports we read that "an examination of girls in board schools for prizes offered by the National Health Society, revealed some curious items of information. One reply to Mention any occupation considered injurious to health' was, 'Occupations which are injurious are carbolic acid gas, which is impure blood.' Another pupil said, 'A stone mason's work is injurious, because when he is chipping he breathes in all the chips, and then they are taken into the lungs.' A third says, 'A boot-maker's trade is very injurious, because the boot-makers press the boots against the thorax; and therefore it presses the thorax in, and it touches the heart; and if they do not die they are cripples for life.' With a beautiful decisiveness, one girl declares that 'all mechanical work is injurious to health.' A reply to a question about digestion runs, 'We should never eat fat because the food does not digest.' Another states that 'when food is swallowed it passes through the windpipe'; and that 'the chyle flows up the middle of the backbone and reaches the heart, where it meets the oxygen and is purified.' Another says, 'The work of the heart is to repair the different organs in about half a minute.' One little physiologist replies: 'We have an upper and a lower skin; the lower skin moves at its will, and the upper skin moves when we do.' One child ennumerates the organs of digestion as 'stomach utensils, liver, and spleen.'"

In the clever little book compiled by Miss Le Row, entitled

"English as She is Taught," appear the following genuine answers by pupils in reply to questions upon physiology and hygiene. Presumably most of these answers are from American pupils in American schools:

"Physillogigy is to study about your bones, stummick and vertebry." "When you have an illness it makes your health bad as well as having a disease." "The body is mostly composed of water and about one half is avaricious tissue." "The body has an infinite number of bones joined together by the joints." "The spinal column is made of bones running all over the body." "Digestion belongs to the lower animals." "Digestion is the circulation of blood." "Digestion is reducing our food to plump." "Digestion is when food is taken into the stomach." "The gastric juice keeps the bones from creaking." "The eyes are set in two sockets in a bone which turns up at the end and then becomes the nose." "The three coverings of the brain are the diameter, the perimeter and the trachea." "The growth of a tooth begins in the back of the mouth and extends to the stomach."

As an additional contribution to answers, we add the following, taken by the writer from the note-books of pupils of one of the *high-schools* of this country:

"Anatomy is dissecting of bodies generally lifeless." "Anatomy is study of parts of the body, physiology study of action of parts, hygiene is *application* of these parts" (italics are ours). "Kinds of bathing, adapted to the age, quantity, quality and health of the person." "Supernator are the muscles about the back." "The hygiene of a muscle should have proper rest and exercise." "Hygiene is the study of the time and manner of the action of the muscles and large blood-vessels." "The mouth is the commencement of the alimentary canal, and it extends through the throat, œsophagus into the stomach." "The extent of the mouth helps the digestion of food." "Nervous system a decided part of the body." "A young person who goes to parties and has great excitement has generally some brain trouble, such as St. Vitus dance." "It is far more reliable to drive out the fire of a room and put on extra clothing than it is to put on no clothing and sit in front of a burning fire." "Soap is important in carrying off the fat of the body." "What is eaten by the body has sometimes been taken as food." "The third cavity is the pelvis, which contains the vital organs." "In a diet of twenty-four hours a man should eat some of all the nutritious articles." "The first step in digestion is mastication and insalivation. Second, the muscles of the gullet." "A person is in fair health when he has the affinity to accommodate himself to change of climate and the ability to endure." "Respiration is the exchange of carbolic acid for oxygen." The substitution of carbolic for carbonic acid is fre-

quently met with. "The times for bathing depend on the age of, location of and heat of the individual."

The bad spelling so frequently found in these note-books shows, of course, ignorance or carelessness, either being reprehensible. Œsophagus is spelled "esofergus," "ecophagus," "sasofagus," "esolpusgult," "sarcophagus," "desophagus." The pancreas is spoken of as "the pangueous," or "the pantheis"; the parotid or salivary glands as the "perodic," "the galviatory and savilary glands," "the spiratory glands." The cerebrum is "the big brain, or celebra"; the cerebellum, "the little brain, or sedula." Suture-joints are "sucher-" joints. Hygiene is "hygine," or "hygene." Adipose is "adicose"; sweat is "swett"; osseous is "oscius"; cancellous tissue is "tenselous"; thoracic duct is "carasse duck," and so on.

Enough illustrations have now been given of the ignorance and carelessness of pupils in regard to anatomical, physiological, and hygienic knowledge to warrant us in saying, when taken in connection with the character of some of the text-books in use, that in many schools these subjects are improperly taught. But it will be said by some: "The fact that such and such text-books are unreliable in pictures and text does not prove that the teachers using them are guided by the unreliable material, and also the fact of faulty and absurd answers by pupils does not prove that these very pupils do not have a very fair general idea of the subjects they were questioned upon." Our answer is, that until teaching becomes, with the majority of female teachers especially, something more than a mere makeshift till marriage looms up, very many teachers will be guided solely and absolutely by the book they are using, and as long as favoritism and cupidity prevail in school-book committees, books will be adopted by school boards which are unreliable, mere compilations, written by persons who in some instances have confessed their incompetency as authors.

In regard to the second assertion, the answer is, after an experience of over twelve years as a teacher, and after conversation with many excellent educators and the examination of many hundred note-books, the number of pupils who have correct views as to the truths of physiology and hygiene is comparatively small. Ask some of the boy and girl graduates of your schools why it is that a certain amount of carbonic-acid gas in a well, cellar, or cave may be injurious to human beings in contact with it, and not injurious to persons in a room or hall, or which is the most nutritious food, or what produces and maintains the animal heat of the body, and notice how few give even reasonable answers. Yet a goodly number of these girls will be the future teachers. Listen to the curious and absurd statements of what

should and should not be used, eaten, worn, tasted, looked at, touched, etc., which are rehearsed by little children to their parents as coming from the primary teachers or the heads of primary departments, and then it will be perceived that the teaching of physiology and hygiene is not what we have a right to expect. What are the remedial measures?

1. Encourage the sale and use only of reliable text-books written by physicians or sanitarians who have had experience as teachers. The mere compiler will magnify the importance of what may be considered by comparison as the non-essentials, and will endeavor to perpetuate absurd and untruthful statements simply because they sound well.

2. Health boards, health societies, and sanitary associations have instructed by this time a goodly body of physicians in sanitary matters. These men and women may well be called upon to outline hygienic teaching, if not to be practical teachers themselves. In addition to instruction in normal and model schools by such special teachers, there should be a sanitary supervision of schools. The physicians appointed to do this work should look after the ventilation, lighting, and cleanliness of the school-buildings, the spread of contagious disease, the condition of wardrobes and closets, the vaccination of school-children, etc. In some cities the attempt is made to do this work through the health authorities, but it is unsatisfactory, as the physicians doing the work are, for the most part, political appointees, and not chosen for their knowledge of health matters. The work should be done by sanitary officers of boards of education. With proper teaching and proper sanitary supervision of the schools, hygienic subjects would be real to the pupil, and the value of hygienic knowledge would be so apparent that interest instead of apathy would be the rule. In 1873, at the annual meeting of the American Public Health Association, President White, of Cornell University, said: "First, as regards public schools, I would make provision for simple instruction in the elements of physiology and hygiene, either by the use of some short and plain text-book, or, what is still better, by lectures from some competent resident physician. I confess that I greatly prefer the latter method. Not only theory but experience leads me to prefer it. Were it not that we have made a great mistake in our systems of public instruction by severing our common-school instruction from advanced instruction, we should by this time have a body of teachers in our common schools abundantly able to lecture to the pupils without a text-book." It is now seventeen years since these words were uttered, and what do we find in regard to the teaching of physiology and hygiene? Just this, that the number of physicians who teach in the schools is very small, that the average teacher

of these subjects on duty has her teaching warped by her hobbies in regard to food, air, or some other hygienic measure, that she does not seem to be able to distinguish between essentials and non-essentials, and is carried away, it may be, by the dress or alcohol question. It has been found by experience that something else than the ability to lecture is necessary in order to get children to have correct ideas of the subjects taught. The daily drill, the "line upon line and precept upon precept," the bringing of the pupil up to the level of the teacher by the teacher's coming down to the level of the pupil, are all necessary. It is probably because these were deficient that we are able to record the answers to questions in the earlier part of this article. It is not a question of how much such and such a child ought to comprehend, but how much does the child understand.

All honor to the teachers who do make the subjects they teach understood as well as interesting.

3. What to teach. The teaching should be reliable, interesting, practical, in order "to inculcate sound national views regarding the necessity of obedience to laws of health, to secure willing obedience to the enforcement of sanitary law, to correct social and personal habits which are constantly operating as causes of disease." If the evils of alcoholic drinks are to be portrayed, as they undoubtedly should be, let the teacher show the relation between intemperance, crime, and immorality, and how intemperance results from imitation, habit, disease, and poverty, rather than spend her time in endeavoring to detail the dire effects of alcohol upon every tissue of the body, and to picture upon the child's mind what a drunkard's stomach looks like, or what a hob-nail liver is. Let her not forget to teach about intemperance in eating, exercise, bathing, study, etc., and to have an eye upon the evil effects of opium and cocaine intemperance, which are not uncommon. Let her encourage self-control, mental, emotional, sexual, physical. Have her dwell on the advantages of "lend a hand" societies, rather than on prohibition measures. The teacher can show how "health is wealth," what are the advantages of a healthy home and surroundings, how disease tendencies can be overcome, what "filth diseases" are and how they can be averted, how economical and nutritious food can be obtained and how prepared for eating. "In the personal habits of pupils, in the ventilating and heating of school-buildings, in the location of wells, in the character of the out-building, in the construction of school-houses and laying out of the grounds, in a proper observance of the purity or impurity of the water-supply, in the enforcement of laws for preventing the spread of contagious and infectious diseases, and in many other things practical truths may be instilled into the minds of pupils, and impressions made that will never be effaced in after

years." These are some of the subjects that should be taught, but in order to insure such teaching, the teachers, especially in the primary grades, should have some definite plan and instruction given them by competent and practical physicians. Were this done there would be less overloading of pupils with technical and unnecessary anatomical knowledge.

4. How to teach. Now that the study of psychology is fashionable we may hope, perhaps, for a better knowledge on the part of teachers of what is and is not necessary for healthy mental activity and development, what are rational methods of teaching; but as long as text-books are ground out, in questions and answers, just so long will memorizing be the rule for pupils, and the encouragement of observation and originality be the exception. Yet the child can be taught by practical methods and appliances about the admission of light and air to a room, simple tests for the purity of water, about filters, what soils obstruct drainage, why sewerage and drainage are necessary, what to do in accidents and emergencies, etc. The desire of the average child to observe and ask questions can be turned to good account instead of being stifled by rigid routine work. The energy born of observation and the intelligent application of what is learned by observing is healthful. As Herbert Spencer puts it, "Success in the world depends on energy rather than on information, and a policy which in cramming undermines energy, is self-defeating."

If the teaching of physiology and hygiene is to be of service in strengthening the growth and development of individuals and communities it *is* a matter of moment that these studies should be properly imparted.

THE UNITY OF SCIENCE.*

By M. J. MOLESCHOTT.

ONE of the greatest anatomists of the age and a distinguished jurist were sitting together at the festival of a German university. They were engaged in a friendly discussion as to which of them should, by virtue of his profession, be best known to the world. At last the lawyer surrendered his claim, remarking that the arteries and muscles were the same in America and Europe, while it was doubtful if the ideas of the Roman law enjoyed a like extension. But I do not believe that the illustrious naturalist felt any great joy in the victory he had obtained; for both professors were brave defenders of the universality of science in the highest sense of the word, and were certainly not expressing their most serious thoughts in this moment of by-play. How much, during

* Address at the reopening of the University of Rome, November 3, 1887.

the half-century that has passed since this conversation, the feeling of the unity of science has advanced, and to how great a degree it has entered into the intimate convictions of the most learned men, does not need to be told.

At a time when all students are avowing themselves bonded in the universality of science, the speaker who is called upon to discuss the subject finds himself in the face of an audience whom he has nothing to teach, but from whom he has much to learn.

A natural inclination leads him to consult, first, the biologists, who have probed to the earliest manifestations of life on our planet; and he is seized with wonder at finding that paleontology, emancipated from the curious contemplation of extinct organisms, has risen to phylogeny, and is following in the host of vital forms that order of evolutionary succession which causes the most recent beings to be regarded as the descendants and heirs of their predecessors. Biological paleontology judges the law of successive evolution to be immanent in the development of species and of individuals. It discovers that the development of the most perfect beings on the earth is made after the form of the generations which preceded those elevated organisms, in such a way that every example of ontogenic evolution appears to be a rapid summary of the phylogenic evolution that preceded the appearance of the being the embryology of which is studied.

Every organized form is fitted in as an essential link in a chain of derivation and descent. Nothing is now left of that fancy that saw in the plan of Nature a mass of accidental variations, like the caprice of an author who published at the same time with his finished works all of his rough draughts and printers' proofs.

At the point we have reached, natural history, regarded as biogeny, can not do without paleontology. Zoölogy affirms that there ought to be transitional forms between reptiles and birds, which present many points of contact and traits of fundamental analogy; but such forms are not found among the beings of our age. Paleontology, however, shows that in the secondary or mesozoic age there lived reptiles having the form of birds, and birds having the form of reptiles.

Just as the paleontologist has taken his place among biologists by investigating the characters of successive developments and discovering and reconstructing the relationships of extinct organisms, so the archæologist has, through ethnography and ethnology, without perceiving it, entered the same camp.

It is the same with whatever relates to civilization. Sometimes the parts are reversed. The linguist asks the physiologist to investigate the laws of phonation and to study accents, analyze the quality of the sound of the vowels, and the sounds that correspond with each consonant, among different races and in different prov-

inces and cities; while the physiologist insensibly acquires the skill and erudition of the philologist.

For a long time doctors believed that they had included all the causes of disease in virulent matters, the inclemencies of the atmosphere, abuses of strength and pleasures, and indulgences of passion. The part of parasites was regarded as limited and secondary, and of those, animal parasites were regarded as the most important, while vegetable parasites were not supposed to play any appreciable part. During the former half of this century, the most intelligent persons considered botany as a part of natural history, very fit to discipline the senses and strengthen the understanding of the future doctor, to cultivate the spirit of observation within him, and to exercise him in the construction of syntheses which would permit him to classify the phenomena. The study of botany was valued only as a gymnastics of the intelligence. It was often forgotten after the first years of study, unless it was modestly called to mind to illustrate the difference between one medicinal plant and another, as parsley and hemlock, or a poisonous and edible mushroom. Now, behold the whole camp of etiologists and a good part of the camp of anatomo-pathologists pressing into the minute examination of the lowest plants, most of them belonging to the group of those microscopic fungi which are divided transversely and owe to that division an extremely rapid increase. These fungi are called, on account of the division which they undergo, schizomycetes. In many maladies, and those of the most grave, one of these species of fungus is considered the determining cause of the disease. The schizomycetes are the invisible enemies of the health of man. The chief defense against them is indirect; it consists in taking care that they do not, through hygienic deficiencies, find in the body of man a fertile soil predisposed to receive and feed them. Hence these invisible enemies have forced the doctor to interest himself in botany, if only to convince himself that the presence of a noxious fungus does not inevitably imply a sentence of death. Botany, therefore, is not only an exercise in education and an auxiliary to medicine, but it is also an integral part of medicine and a fertile source of explanations. The unity of botany and medicine is in appearance only on the ground of the infinitely little; but the economy of all organized nature is really displayed in it, the cycle of life which includes death—death from which life, the true phœnix, perpetually rises again.

Physics has higher ambitions. Mother of all the sciences, including metaphysics, and ever young in its indefatigable research, it unites the efforts of a matured experience with those of a legitimate boldness. It takes pity on the despair of the chemist who can not catch in his crucible a piece of the glowing shell of the

stars, and teaches him how to make use of a ray of light to discover the nature of those distant substances, and to make sure that they are the same in the celestial bodies as they are in the terrestrial globe, which is also celestial in its turn.

It is not satisfied with overcoming the obstacle of distance, which seems to be insurmountable. If to economize time is the most effective way of enriching men and states, physics has the best right to aspire to the glory of being the peerless servant of all administrations, both of public and private affairs. The physiologist also has physics to thank for giving him the means, through the decomposition of light, of perceiving in an instant whether the coloring-matter of the blood is more or less oxidized, while chemical analysis can make it clear only after long and difficult experiments.

But, while different sciences assist one another by reciprocally facilitating, checking, and perfecting each other's work, there is one that has a superior part, at once foundation and summit, elementary and transcendent. This science is the base of all the others, and distributes to the most positive of its sisters crowns, the precious stones of which are touchstones. All of my learned hearers will divine that I am speaking of mathematics, the Dutch name of which (*Wiskunde*) signifies the science of the certain, the positive science, absolutely science. This science guides our first steps in the highway of thought; it is so blended with the premises of every deduction, that its truths, accepted by the ages, seem to have imposed themselves as axioms, or theses *a priori* innate to the faculty which we call intelligence, and thereby independent of all demonstration. Now, this hypothesis, widely prevailing as it may be (and it is as universal as the belief that the sun rises), the psychologist shows to be erroneous.*

The possibility even of error proves the initiative which we take in the formation of these axioms. They are merely the summary of our first and quite simple observations—a summary which has taken the mathematical form, and seems, under that form, to approach the absolute. It is mathematics which, in all the sciences of observation, conducts to the most precise conclu-

* Moleschott says, in his "Der Kreislauf des Lebens": "We yet teach children that they can reach the highest summits of thought, without any aid from the senses, by starting from certain premises which they have brought with them at birth as an integral part of their intellect, and for the knowledge of which they have only to appeal to their memory. The mathematician calls these premises axioms, and he persuades children as well as men, when he submits them to them, as, for instance, that the whole is greater than a part, and that the whole is equal to the sum of its parts. And yet no child knows it until he has seen, say a hundred times, that an apple disappears when it is cut into four pieces and these pieces are divided among four persons." See also Helmholtz, "Ueber den Ursprung und die Bedeutung der geometrischen Axiome" ("On the Origin and Signification of the Geometrical Axioms").

sions, whether it is employed in representing in figures the arrangement of the leaves of a plant, or in formulating the law of gravitation, or the law of the enfeeblement of sound and light in the ratio of the square of the distance. It is mathematics that points out perturbations, and imposes limits upon physical laws. It is mathematics that serves to direct the intelligence, whether by showing it how to correct an error of observation, such as Newton had to contend against when he was inquiring if the law of gravitation was applicable to the motions of the moon, or by helping it to ascertain that not all the causes on which a phenomenon depends have been included in a formula to which the facts refuse to adapt themselves. In short, mathematics is a beacon-light and a means of verification. It inspires all the more confidence because it is the only science that has never had to change its direction, from Euclid to Galileo, from Newton and Huygens to Laplace and Lagrange.

It gives form as well as foundation to knowledge. No draughtsman can hold a contest with graphic geometry in any question of figuring the relations of different phenomena that are functions of one another.

Mathematics is the draughtsman of thought. The beauty of the formulas by which it has been the prophetic guide for the other sciences can not be forgotten; as in the discovery, for example, of the series of homologous compounds by which chemistry has been so greatly enriched. This science, which has produced so quick a revolution in the conscience, force, and art of life, owes to mathematics the concept of valences, and consequently the knowledge of the mechanism of substitutions, the variations of which are so infinite as to belie the maxim, "There is nothing new under the sun."

It is mathematics that renders the honors of positive knowledge to ancient times, in that period which, besides having become classic for its art, also laid the foundations of science, and made the Greeks masters of the true as well as of the beautiful; whether with Pythagoras, Euclid, and Archimedes it established the bases of geometry and mechanics, with Aristotle founded natural history, with Hippocrates introduced the art of observing and questioning, or with Plato made the method of discussion an art of reflecting ideas in the mirror of facts.

Hence, the person who sees only labor lost in philosophical researches, is in error. Philosophy (I am speaking of speculative philosophy) has not gone on a journey from which it has not returned, but, having traversed heaven and earth with vigorous will, has come back to tell that it has not succeeded with its *a priori* theories in solving the problems which impose themselves upon all thinking men. That is the confession which Dr. Faust

makes when, after having studied all the sciences, he realizes that no one can attain knowledge without plunging into the reality of life. Yet we do not believe that philosophy has forfeited the glory that is due to every sincere effort, in whatever order of research. It was necessary, indispensable, and certain, that reason, escaping the limits of things, should exhaust itself in tentatives. Did not Plato of necessity create Aristotle, and stoicism Lucretius, in the same way that Bacon and Descartes, Galileo and Kant, were born of scholastic and dogmatic thought ?

Philosophy (I am not speaking of speculative philosophy this time) now comprehends that it can aspire to fill only two missions: to be the synthesis of all our knowledge, and to generalize the method which ascends from facts to ideas, persuaded that the idea springs from the fact and does not create it. In this sense philosophy, suffering modifications as time goes on, will be always the synthesis of the known (not of the knowable), and, freed from that which is of speculation and ideology, will remain the guardian mistress of the harmony in which the true, the beautiful, and the good are to be blended.

Thus there remains a task for philosophy that peculiarly belongs to it—one of the noblest tasks—to examine the solidity of the bases of morals, independently of customs and the prejudices of individual nations and times; and ethics is not separable from æsthetics. So understood, philosophy is the science of sciences, or absolutely the science, the guarantee of progress, the guardian of morals, the mediator between science and art, the supreme expression of liberty of thought which admits neither innate ideas nor revelation. We comprehend everything under the ægis of such a philosophy, precisely because method has become single.

The long-cherished contrast between the positive and historical sciences has disappeared, for we are persuaded that the point of departure in this also is observation, that the continuity of facts must be followed step by step in seeking out the law, in tracing the concatenation, in order to rise to the conception that all has become what it was necessary for it to become. Harmony in the universe is inherent to the beginning of things; and if we could embrace them in a single glance we should see that first causes correspond with final causes; and teleology and causality would be merely the two faces of the same medal.

Unity of method conduces to the union of the exact sciences and of historical investigations, of jurisprudence and anthropology, of biology and military art, of politics and statistics. From this marriage have been born the social sciences, which have come to demonstrate that society has its evolution, its exigencies, its diseases, and, in short, its laws like the individual, and that it is necessary to calculate facts and observe their march in order to

be able to act upon the influences on which that march depends and by which it is regulated.

The objective of the social sciences is to neglect no factor of life. It is only by a ponderous and progressive labor that can be realized that amelioration of the social conditions which can never be attained by a sudden leap, but which we can see in fact preparing and asserting itself by a gradual and continuous evolution.

The evolution of mechanics, of which the strongest, most adroit, and most expeditious workman is electricity, is daily reducing the muscular labor of man. By virtue of the principle of the conservation of energy, the diminution of muscular labor is of advantage to intellectual labor, in quantity as well as in intensity. Attention becomes more profound, intelligence more quick, judgment more sure. The danger of the workman of modern times becoming brutalized is, without any doubt, greatly diminished. The workman has become more polite, more reflective, and more human, and is advancing further every day toward the conquest of the more considerable place in society which he merits. Not only the quantity of intellectual labor has been advanced by the technical applications which science has made possible; we have a right to ask also if its quality has not gained still more.

The telegraph and the telephone have made all the world more expeditious, more attentive, more ready in its judgments, and more prompt in its decisions. Recollect the perplexity into which, thirty years ago, a letter demanding prompt advice or immediate assistance would put us. Knowing that we had time, that we should have to wait several hours before sending an answer or beginning a journey, we gave ourselves up to doubts; and, when doubt possesses itself of a man, his judgment is often obscured and his will paralyzed. Now that we have to leap the ditch, to think on the instant, and turn our good-will at once into action, thought takes wings, and our decision is resolute and bold.

In this way Volta and Galvani have become powerful educators. By their scientific discoveries they are teaching our sons to think readily, to will firmly, and to express themselves briefly, in a manner precise and conformed to their thought. A rapid physical means of communication triumphs over torpor of the intelligence, indecision of character, and prolixity in speech. Further, this electric pile has become the mother of the postal-card, another mistress of simple and pertinent words. The later generations know so well how to use these instruments that to some the postal-card is already too large. In a very few lines they can assure friends of continued affection and produce the illusion that one is for an instant enjoying their presence, feeling their caresses, and experiencing the stimulation of their spirit. Economy of time leaves leisure to write short letters, for which there was not

time in Pliny's day; and the exchange of thought has gained as immensely as the exchange of friendly sentiments. In this way it is a fact that every application of science develops the moral force of man.

Man measures the universe, and he measures himself in the rapidity of his thought and will, and finds the relation between the world and himself. He knows that he measures with relation to himself, that he measures with his senses; and in the relations between them and the world, in the necessary relation which unites them, he finds the human absolute. Reducing all the measures to a single scale, he discovers the unity of the science for which there exists a law that embraces all, anthropology. Anthropology examines the nature of man, the civilization of man, his laws, his errors, his poetry, his ideal. This ideal, which must go on ascending in proportion as man attains knowledge of himself, consists in the harmonious development of the species; and this embraces all the factors—the functions, passions, and aspirations—of his moral being. The more the individual assimilates himself to it, the more this harmony makes of man a work of art, the more it gives him the faculty and the right to admire and love his title of man; because he finds the reason of the good and the beautiful rooted in his nature. Anthropology embraces ethics, æsthetics, and history.

Hope comes to fortify the ideal at an epoch when we are comprehending the transformation of force and of form; because, with this conception of the conservation of force, all phenomena and all the moral manifestations of men may perfect themselves without ever striking upon an ultimate limit. Against such an ideal, against such a hope, the shadows of ignorance and the discouragements of pessimism will never prevail. The shadows are afraid of a statue,* and pessimism has no courage but that of despair. But the poet (Victor Hugo) has said with right, "Whoever despairs is in the wrong." He who does not despair and who works carries in his own conscience the fruit and the recompense of his efforts.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

Prof. Prestwich, in a paper on the date, duration, and general conditions of the last glacial period, estimates the date of the melting of the ice-sheet at from eight to ten thousand years ago. He admits the appearance of man in Europe before the spread of the ice over the continent, and assigns the residence of neolithic man in Europe—although he had probably been established in the East before that date—to some three or four thousand years B. C.

* I mean the statue of Giordano Bruno. The place selected for its site (also a very natural location, and the only one worthy of it), the *Campo dei Fiori*, where it looks upon the spot where the heroic thinker was burned, is a protest against clerical intolerance.

THE PARLOR-GAME CURE.

By Rev. THOMAS HILL, D. D.,
EX-PRESIDENT OF HARVARD UNIVERSITY.

SOME forty years ago, a distinguished citizen of Boston was caught, by an intimate friend who entered without knocking, in the very act of reading Bowditch's translation of the "Mécanique Céleste." He excused himself for the unfashionable character of his reading, by saying that he had thought he would refresh his memory of his college-days. But the friend drew from the wife a better explanation. The good man was a heavy stockholder in a company which had been almost brought to bankruptcy by the thefts of a dishonest treasurer; and he was reviving his mathematics as a means of diverting his mind from the unpleasant topic, which had begun to weigh too seriously upon him.

Those who have had no early training in these severer studies, refresh their minds, when wearied with business anxieties and cares, by a lighter sort of reading. The diversion which refreshes and reinvigorates a man must be one that is suited both to his peculiar tastes and to the character of the fatigue or anxiety which has worn upon him. That which interests and refreshes one man may weary another; that which banishes the thought of one kind of trouble, may recall and aggravate the causes of distress to a man whose anxiety or weariness has arisen from a different cause. The "Mécanique Céleste" served a good purpose for our Bostonian; while a novel which turned upon a plot involving breach of trust, and the ruin produced by it, would have been only a means of increasing the sufferer's trouble.

This is the real and substantial value of parlor-games. They serve as means of cure for those sufferings which arise from mental causes; they do so by diverting the mind without overtaxing it. It is true that many parlor-games may be used for gambling—or rather abused—but they are not on that account to be wholly condemned. Indeed, there is, in the very fact of a thing being capable of doing mischief, a presumptive proof that it can do good; by the correlation of forces, any energy can be turned into a useful channel. A substance absolutely inert would be capable of doing mischief only when present in a sufficiently large quantity to impede the useful action. Keeping to our comparison of games to medical agencies, we may perhaps get some light from a curious remark of Liebig. His theory, as we dimly remember it, was somewhat to the following effect: When any article is received into the stomach, a contest begins between the gastric powers and the intruder. If they conquer, the article was

food; if they are conquered, it was poison; but if it is a drawn battle, the article is medicine. To a certain extent, this theory certainly embraces truth; although it is equally certain that it does not cover the whole ground of therapeutics and hygiene.

Pastimes and games are justified to the moral sense by their sanitary value. Cards, dominoes, and the backgammon-board are as manifestly means of health as hair mattresses and ventilating-flues. The dice-box, as used in backgammon, is often more valuable to an invalid than the pill-box. But the very fact that games are thus valuable as medical agents, proves that they can not be a wholesome article of diet; they are not valuable enough to be made a continual occupation; they do not furnish sufficient food to the mind. So far as that, we might apply the Liebig theory to them. If a man were, for example, to take up chess after the manner of Paul Morphy, master all the possible combinations so thoroughly as to be able to checkmate every adversary, and that, with any pawn designated by lot, at the beginning of the game, such a man would evidently have made more than a pastime of chess. It would have been food for his mind; just as really food, although not so valuable, as Euclid's "Elements," or Legendre's "Theory of Numbers." If, on the other hand, a man, without Morphy's talent for chess, should become infatuated with the ambition of gaining Morphy's skill, and should spend a disproportionate amount of time playing, his right hand against his left, then to him the game would be poison. Its sanitary use, as a recreation, is evidently attained only when a man pursues it just far enough to divert his mind completely from the thoughts which were injuring him, and not far enough to make it in itself an absorbing occupation.

The late Prof. Peirce once said that no game, and no toy, ever became permanently popular unless it involved some deep and peculiar mathematical or mechanical principle. He asserted it as a fact of observation, but we never heard him attempt to account for it. The theory which we are ascribing to Liebig furnishes a partial explanation. The presence of this deeper principle, underlying the game, prevents it from being digestible by any except those of strong power. To all others the game may be considered either as a poison, when it is utterly beyond their reach to do anything with it, or else it is a recreation of permanent sanitary value; that is, when the patient can acquire skill in it, but is not tempted to try to fathom its mathematical principle. Pierce's meaning may be illustrated by familiar examples. The child's top, his hoop, his bandelor, his devil on two sticks, all involve the same fundamental doctrines of rotation on an instantaneous axis, which task the mightiest powers of the geometer in their application to celestial mechanics. Ball-playing, quoits, hurling of spears, throwing

at a mark, involve the addition of two other famous mathematical principles; namely, the epicycloids of Hipparchus, and Galileo's law of gravity. Billiards bring in the insoluble mystery of friction, which creates a breach of continuity in the path of the ball. Cards, backgammon, and various games for the evening at home, involve the doctrines of permutations and of chances.

In the ancient astronomy the planets were imagined to be carried on the ends of revolving arms, which themselves were carried by arms rotating more slowly, these latter arms again being carried by arms of still slower rotation. This epicycloidal motion of Hipparchus is evidently closely analogous to the motion of the human hand, which rotates upon the wrist-joint, while the wrist is carried in a circle about the elbow-joint, the elbow in a circle about the shoulder, and so on. The ingenuity of Hipparchus had, as it were, contrived a huge imaginary man, carrying the planet between his thumb and finger. The friction of the billiard-table diminishes the rotation of the ball upon the instantaneous vertical axis at such a rate as to bring it presently to an end, leaving only the rotation upon a horizontal axis. At this moment the curved path of the ball becomes instantly a straight line. Cards involve the smallest prime number, and that in two ways, there being two colors, red and black, and also two suites of each color. Cards also involve the relatively high prime thirteen, and, less conspicuously, the intermediate numbers. They furnish, therefore, the opportunity for an almost endless variety of permutations and combinations; and if these are produced by shuffling, they involve also the doctrine of chances. We ourselves do not know how to play a single game of cards; therefore, on Sydney Smith's principle of never reading a book before he reviewed it, for fear of becoming prejudiced, we can speak of them in an unprejudiced manner. Their universal popularity we have just explained. But it is a nearly invariable rule that the best things are also the worst. Fire is a good servant but a bad master; and strychnine, one of the most valuable of tonics, will kill a man as promptly as it will a wolf. Cards are capable of great abuse, and they have been so greatly abused that many persons interdict their use also. Yet they have a use; and their sanitary value as a recreation and diversion of the mind is, in certain cases and for certain persons, very high. The invalid needs rest, and often finds the best form of rest in the exercise of different powers from those which have become fatigued. This is as true concerning mental as concerning bodily exercise. When a man is tired, weighed down with anxiety and care, or with a continuous application of the mind to one set of questions, his brain is apt to go on automatically, tiring itself and its master, producing even in sleep restlessness and dreams. Such a man obtains rest more easily,

and a sounder, more refreshing sleep, if his mind can be diverted for an hour or two to some different train of thought, which ought to be barely interesting enough to keep his attention without producing excitement or requiring strong exertion.

Two elements which enter into a game are of prime importance—chance and skill. In the latter word we include both manual and mental skill. For example, in cup and ball we have an instance of a game requiring nothing but manual skill; while in jackstraws, it is a combination of chance with manual skill that determines the result. Again, in checkers we have a game of pure intellectural skill, but in backgammon intellectual skill is combined with chance. Skillful physicians prescribe for a patient that kind and degree of exercise which is suited to his case—to one a rocking-chair on the south piazza; to another a good round trot out of town on the saddle. Thus, in the evening games, which shall rest the tired worker, or divert the invalid, there is a great opportunity for wise choice in selecting those which are best suited for the purpose in view. Men of intellectual habits, who need rest for the brain and diversion for the sake of rest, find the greatest benefit in those games which demand constant attention, but comparatively little mental exertion. The late Charles Robert Darwin astonished the scientific world by the immense amount of labor which he successfully accomplished. One secret of his immense power of endurance unquestionably lay in his devotion to backgammon, in which he so frequently passed his evenings. This game has the admirable qualities, first, of demanding imperiously your attention at every throw of the dice; and, secondly, of giving you a comparatively easy question in the use you are to make of the throw. There was even an advantage in the old fashion of invariably calling out each throw in mongrel French before playing; it still more fully occupied the mind with "easy nothings." The preponderance of chance over skill in backgammon is a fourth recommendation of this game for a tired brain. It produces a constant but slight expectation or watching to see what will turn up. In the Russian game, however, it has appeared to us that the preponderance of chance was too great; it does not leave enough demand for skill. This, also, is the objection to dominoes.

In rude antithesis to backgammon and dominoes stands chess. This game can not be said to be popular, in the strict sense of the word, and the reason is evident—it is too severely intellectual. It is a very famous game; so also are Newton's "Principia" and Butler's "Analogy" very famous books. But neither of the three are likely to be found on the sitting-room table as an amusement for either old or young when needing recreation. Moritz Retzsch's marvelous picture of the young man playing chess for

the stake of his own soul has been far more popular than the game itself.

The stake of one's own soul is not often, if ever, consciously made; but one of the abuses to which we have alluded is the habit of staking money or things of money value upon the issue of a game. To say nothing of the moral character of gambling, the stake of even sixpence is just so much detracted from the real interest and value of the game itself. Wagers of every kind, for even the most trifling amounts, are to be avoided; they are essentially bad. But when they take the guise of forfeits or prizes in games, they are doubly mischievous, injuring the utility of the diversion, as well as fostering, to some trifling extent at least, that gambling spirit which is one of the great destructive agencies to the human race.

Another ground on which games may be classified is the manner and amount to which the social element enters into them. Here, again, cards have an advantage, which greatly increases their favor with the people. The social element enters into cards in a great variety of ways. There are games admitting several persons, but requiring all to keep whist; there are games admitting several persons, and allowing free conversation. There are games for two persons, and there are various solitaires. An invalid's hours are often necessarily spent in solitude; and he tires of reading, of whittling, of crocheting, or knitting; and yet tires of idleness. Then a solitaire is valuable; and he may choose, from the solitaires at cards, a kind which shall suit his taste and his needs; since the different solitaires in cards vary greatly, in the amount of thought and of skill required to play them.

The severely intellectual game of chess offers also a numerous set of solitaires. Every chess-column in a newspaper furnishes problems of greater or less difficulty. A diagram gives the position of a few pieces toward the close of a supposed game; and the party to be victor is required to checkmate, in a specified number of moves. Setting your men according to the diagram, you play for both parties; endeavoring to prevent the game from ending so soon, and yet endeavoring, with equal fidelity, to bring it to a close as required.

The new game of halma, which has acquired so sudden a popularity in some parts of the country, furnishes, like chess, an unlimited variety of problems; either one of which may be considered, like any enigma or puzzle, a solitaire. The most general statement of a problem in halma would be, to move a given number of men from one given position to another, in a given number of moves. One problem proposed by ourselves has proved so wonderfully rich in the number of possible solutions, that we

may be pardoned for repeating it here: "Place nineteen men outside a yard of nineteen squares, in a figure symmetrical upon the diagonal of the board; such that the men may all be yarded in nineteen moves." Of course, the problem, in this form, is too difficult for a direct attack. It must be solved by reversing it: "Place the nineteen men in a yard, and bring them out into a symmetrical figure in nineteen moves." At first, it is very difficult to get them out at all, in nineteen moves. As you go on, you find more and more of symmetrical figures, into which you can arrange them. One young friend has found nearly eight hundred figures, arising from only three different ways of making the first seven moves. Another player has discovered nearly twenty ways of taking the first seven moves. This seems (in spite of the fact that some of the symmetrical figures are capable of being produced by different modes of approach), to indicate that there are, probably, four or five thousand different figures which fulfill the conditions of the problem. There is, therefore, in this one question, an unlimited amount of amusement, for those who fancy that kind of work, moving the men out and moving them back, in thirty-eight moves.

These problems in chess and in halma are problems of pure intellectual skill. We chanced, a few months ago, to have had a problem suggested to us, requiring no skill, but depending wholly on chance. Meeting, in a Pullman car, a little Mexican boy, not yet six years old, we were surprised to have him produce a dice-box with five little dice and propose to throw for money. When he found us inflexible in refusing, he began to throw for himself, and, keeping an audible account, credited us, in fun, with the alternate throws. We then began to make a memorandum of the number of pips up at each throw of his five dice. Ten throws were equivalent to fifty throws of a single die, and it so happened that his first ten throws gave one hundred and seventy-five pips; the precise theoretical average of fifty throws of a die. It then occurred to us that some persons might find it an interesting solitaire amusement to record a large number of throws made at successive times. The interest would arise in comparing the actual averages of ten consecutive throws, or fifty, or a hundred; and of consecutive tens, fifties, etc., with the theoretical averages. These comparisons might extend from the average of the number of pips up to the number of doublets, triplets, and other special combinations, produced by consecutive throws, or by simultaneous ones. The labor of calculating the chances (how often, for example, with a pair of dice, doublet aces should occur, and how often they should be instantly followed by quatre ace) should be performed by a person in health, and the invalid amuse himself by simply recording a large number of throws, and seeing how

nearly the actual frequency of occurrence agreed with the theoretical average frequency.

We might mention, also, a number of parlor-games which involve some degree of muscular exercise; and others, like the game of twenty questions, which require vivacity and brightness in the use of language. But the main principles to which we wished to call attention have been sufficiently illustrated by the sedentary games and solitaires which we have already mentioned. The therapeutic value of a game depends upon its adaptation to the individual tastes and needs of the person who takes it up. It must be such as to interest him and keep his attention, and yet not such as to absorb, excite, and fatigue him. His native and acquired tastes, his age and habits of life, the state of his health, the causes of his fatigue, or of his illness—all these, and other similar causes, will influence the effect that any particular game or amusement will have upon him; and in the exercise of a sound common sense, by himself and his friends, he will select and vary his amusements as carefully as he selects his various occupations, or chooses his diet.

DRIFT-SANDS AND THEIR FORMATIONS.

FIVE large sand-tracts may be designated in Europe—the German lowland, extending from Holland through Germany to Russia (about 340,000 English square miles in area); the Dano-Germanic island plains (20,000 square miles), including Schleswig-Holstein, Denmark, and Jutland; the Austro-Hungarian Danubian plain (about 42,000 square miles); the Landes of France (about 5,400 square miles); and the sea-coast sands of Russia, Germany, Belgium, Holland, and France. These extensive regions have, for the most part, either been made amenable to cultivation, or at least protected from the assaults of the winds by preservative plantations. Tracts of this sort are often much more fruitful than we are accustomed to suppose them to be. But there are also in Europe large fields of sand which are hardly if at all covered with plants. They are the dunes and sands on the coasts of Prussia, Pomerania, Jutland, many of the Danish and Frisian islands, Hanover, Oldenburg, Holland, Belgium, and France. Large systems of dunes extend in France from Brittany to near the Pyrenees. But there are also exposed sand-tracts in the interior. The most extensive of them are in Hungary, of which the most important is probably the sand-barren of the Banat. It forms an oval about thirty-five kilometres long by eleven kilometres broad, and has an area of nearly four hundred square kilometres. It presents the appearance of a rolling region with elongated hills,

often resembling mountains, which for the most part follow the trend of the steppe, as well as the direction of the prevailing wind, which is here from southeast to northwest. The hills rise, counting from the nearest valleys, to a height of fifty-five metres, inclining gently on the windward side, but presenting a steep slope on the lee. This steppe has indeed always in historical times included bare spaces, varying in number and extent according to the existing state of cultivation. Till the beginning of the present century the bare drift-sand had so gained the upper hand that there was in the middle of the tract a continuous extent of one hundred and fifty square kilometres in which grass and shrubland could be found only in small spots and streaks. Only the northeastern and southeastern part of the steppe consisted of grass-land, in which bare spaces were likewise not wanting. Many other such sand-districts might be named. For example, there were in the County Pesth, in 1809, nearly 1,600 square kilometres of more or less bare, but not continuous sands.

Let us inquire into the origin of these sand-masses. The open sea is usually bordered by deposits of sand and gravel. Where the shore rises in steep rocks, these deposits are concealed under the water; but where the coast is alluvial, as is generally the case in the smaller seas, the whole shore consists of sand and shingle; and the sea-drift extends up upon the dry land. The waves are constantly bringing up new material to the beach, chiefly consisting of fine sand. A storm stirs the water to a considerable depth, pushes the sand forward, and bears it with the waves high upon the shore. On the retreat of the waves, a part of the sand remains, because it is specifically lighter than water. When the storm has subsided, and the sea has withdrawn to its proper limits, the sand becomes dried, and falls under the power of the strong, restless wind, which takes up all the fine particles, and when it rises to be a storm wind some of the coarser ones too, and carries them away into the country. Here it meets impediments of various forms and efficiency; then it drops its load irregularly, and gradually piles up along the shore those hills which are generally known as sea-coast dunes.

This edging of dunes which borders the flat sea-shore is of various breadths in different places. In some places it becomes so piled up as to cause a retreat of the waves. New dunes are constantly formed farther toward the sea, and the dune-zone is widened. Sometimes the widening is effected by the emigration of the bare dunes toward the interior. In other places the dunes are broken into by the sea-water, and suffer loss of breadth.

When there is no overflowing of the shore or breaking up of the dunes, the system usually consists of three more or less connected rows of hills. First, the fore-dunes, which first receive the

material added by the waves; then the high dunes back of them, which, receiving the drift-sand, gradually rise in height and become better fitted to protect the mainland against wind and sand; third, the inner dunes, a series of low hills lying back of the high dunes, which are formed of the sand that is blown over the high dunes. [This division is, however, theoretical, and not always recognizable in the fact.]

The two sides of the dune slope at different angles. On the windward side the rise is gradual, at an angle seldom of more than from 5° to 10°. But the other side is much steeper, and usually offers an angle of 30°. The variations that appear are explained by differences in the cohesion of the sand; coarse sand forms a steeper slope than fine sand. The dunes have an average height of some forty-five or fifty feet; but there are some of greater altitude. In Jutland, for example, and on the Frisian and Courland low ground, and in the Landes, they rise to from one hundred and fifty to two hundred feet. In breadth, they vary from three hundred to three thousand feet; but they reach an extraordinary development in the Landes, where breadths of thirty thousand feet are not rare.

The large sand stretches in the interior were formerly sea-bottoms. Another origin has been sought for the Banat sands of the Hungarian steppe, in the supposition that they are a product of the Danube, which, tremendously disturbed by southeastern storms in the vicinity of Palanka, has thrown its sand-weighted spray into the air to be carried far inward, dropping its heavier constituents along the way. This hypothesis needs to be mentioned only to be contradicted.

It can hardly be supposed that an inland drift-sand district has lain bare during historical time, or since that long-past epoch when the retreating waters left it dry. On the contrary, sand constantly acquires an increasing verdancy through the unceasing efforts of Nature, and becomes at last covered with a thick carpet of the lower plants, or with wood, and thereby fully protected against the wind. This gradual process of binding goes on the more speedily when it is not interrupted by man. The presence of a former coating of humus is easily proved by digging into the sand; for, everywhere that the sand-hills are removed, dark-colored strata appear, which were certainly once surface-soil covered with plants. The wind-blowings occasionally bring to light carbonized relics and reed-shaped holes which are unmistakably derived from tree-roots. Cylindrical massive or hollow tufa formations are also observed, the shapes, direction, and ramifications of which likewise point to roots; and they have probably been formed from roots through the infiltration of calciferous water.

The origin of the bare sand-spots may be traced to the agency of man. The immigrating nomadic populations required for their herds not wood, but pasture and tillable land, and mercilessly cleared away the forest. The land thereby became arid, and wherever a pasture or meadow was not established, the sand, deprived of its covering, became a prey to the winds. Even if this view be regarded as a hypothesis that can not be proved, it is at least illustrated and made comprehensible by events which are historically authenticated or are still taking place. When the Turks were driven out of Hungary, the sand-tracts, for the most part, lay waste. The Italian Griselini, who traveled through the Banat under a commission of the Empress Maria Theresa, wrote: "For nearly eight German miles in length and from nine to ten thousand fathoms in breadth, the sand, when it is not moist, is so fugitive that it is taken up by the wind and deposited in little hills of various heights."

The once well-clothed level sand region of Tidsvild in Zealand, where a religious house was built in the twelfth century, was, at a later date, through carelessness and the destruction of the woods during the Swedish invasion of 1658–'60, given up to the ravages of the winds. Wide tracts and even valleys, like Tomb, and, in 1730, Tibirke, were overwhelmed with sand. The Government was aroused by these disasters, and earnestly undertook the work of irrigating the sand. The enterprise was successful, a fact of which a memorial stone erected in the territory bears witness, in an inscription in Danish, German, and Latin, relating, "The drift-sand was watered at the command of Kings Frederick and Christian, by the faithful industry of Warden Frederick von Granu and Roehl's skilled hand." A similar instance of the letting loose of the drift-sand through the careless destruction of the woods is recorded in East Prussia.

There are cases even now where, through the greed or ignorance of man, bare sand-tracts are allowed to be formed in the midst of cultivated lands. This takes place, for example, where grass-land is pastured to excess, or the turf is trodden out by the too frequent passage of large herds over the same spot. Exposure to the direction of the prevailing winds, subjecting broken spots to frequent sweepings and promoting the washing out of ruts by rains, poor farming, and careless burning of the shrubbery are also dangerous, and in Hungary have led to the enactment of laws regulating the treatment of sand-lands.

As has already been mentioned, the noxious quality of sand consists not so much in its own infertility as in its being subject to transportation by strong winds and deposition upon fertile spots, where it buries and destroys the lower vegetation. When it is thus driven or flies away from its original place, it receives

the name of drift or flying sand. While single grains have but little cohesive force, sand behaves toward the wind like water; and the method of the formation of dunes is undoubtedly very similar to that of the formation of waves. If the sand was quite even and horizontal and the wind blew regularly in the same direction, it would not get at the sand. But the surface of a sand-bed is not even; it consists of the roundish heads of the sand-grains that form the upper layer. The wind blowing over them moves them out of their place, and, the individual grains being roundish, they roll. The continuous pressure of the wind extends their movement, and these grains striking upon the projecting grains that are still at rest, disturb them, and the movement spreads more and more. The smaller grains at last no longer touch the ground, and only the heavy ones retain the springing character of their motion, till the wind is restrained and weakened by some fixed objects—plants or buildings—and is compelled to let part or all of its load fall. These objects are thus exposed to be submerged in sand; and hence it is that we so often see fields of low plants and even villages overwhelmed. It is interesting to observe the different ways in which different objects receive the wind. A tight wall does not catch the sand immediately in front of itself. A furrow is formed just before it, through the generation of side-currents, which receive the sand from actual contact with the wall. There is then formed a sand-ridge parallel to the wall, but at first separated from it by a hollow; but afterward, when the ridge has become high enough to shield the wall from the wind, the side-currents are extinguished, and the sand advances to it. The sand driven over the wall by the wind falls at a considerable distance behind it. A striking illustration of this process was formerly to be seen at the church of Altpillau, on the Baltic. The village, which had previously surrounded the church, was removed farther to the east on account of the presence of the sand, but the church had to be left where it was. A sand-ridge some twelve or twenty feet high was formed around it, but nowhere reached the walls of the building; and while the congregation were obliged to climb over the ridge, they never found the church-doors buried. A broken wall, an open fence, or a quick-set hedge behaves quite differently toward the advancing sand. No furrow is formed in front of it. The air-current forces a large part of its load through the openings, but is so weakened by the obstruction that it drops it before and behind the fence. A little wall is formed around a tree-trunk, which is not, however, of great extent behind it. In isolated bushes and tufts of herbage, the intervals between the single stalks are filled up with sand, and a little mound is gradually formed.

Like the inland drift-sands, the dunes of the coast also migrate.

Fortunately, it is only the dry sand that is destitute of cohesion. Were this not the case, a whole dune might be taken up and removed to another spot during a very heavy storm. Sand possesses considerable capillarity, by virtue of which the ground-water at its bottom rises through its substance; so that an apparently dry dune is so moist only a few feet below its surface, as to form a compact mass. Rain, however, only temporarily lends it a certain degree of fixedness. The air present between the grains of sand permits to rain-water a slow percolation, so that it has been observed, particularly with fine sand, that water ascends in it from below more rapidly than it descends from above. Rain-water, not being all sucked up by the sand, has to run down the slope, and, therefore, not rarely washes deep furrows in the mass. Sand that has been moistened by rain is more tractable after drying than before it was wet, because the interposition of the water has separated the grains, and they are more easily moved by the wind. The wind can only wear away the surface of a dune. It therefore takes the direction of the ascent of the dune, and carries the sand with it. A space free from wind is formed upon the top of the dune, where the larger grains fall upon the ground and run down on its other side, forming a nook in which they are enabled by their cohesion to remain, while the finer grains are carried farther by the wind. The dunes thus maintain their general forms while slowly advancing. The progress of the dunes has been frequently observed, and attempts have been made to measure it. A series of observations for twenty-three years in the barrens of the Banat gives an average of two metres a year. It is estimated, according to Count Adelbert Baudissen, on the island of Sylt, that the dunes are moving from west to east at the rate of four metres a year. Hagen names a rate of five and a half meters a year for two dunes on the Friesian lowlands, and Krause, four metres a year for another one. Elie de Beaumont describes dunes in Brittany that have moved since 1666 at the rate of seven metres a year; and Behrendt gives the average annual progress as from five to six metres.

A traveling dune is stopped by no obstacles. With the irresistibility of an element only slower than water or fire, it presses forward, burying field and wood, and even whole villages. The spires of church-towers may still be seen projecting out of the sandy sea of Brittany, testifying to the presence of former dwelling-places, there. The whole northern point of Jutland has been given up by man to the advancing sand.

In the seventeenth century an old churchyard was found, over which a dune had taken its course, on the Courland lowlands north of Kranz. A sandhill that separated the hamlet Sarkan from the parish-village Rositte, and which had to be crossed by

the pastor, has since then disappeared in the gulf. Great dunes now cover the village of Lattenwalde, which was so laid waste during the Seven Years' War by plundering, quartering of the Russians, infectious diseases, and fire, that the sand had only a heap of ruins to cover up. The village of Kunzen, with its church and seventeen homesteads, was ruined in the same way in the course of the last and the beginning of the present century; and now the dune, continuing its journey, has permitted the skulls and skeletons of the former churchyard on the west side to be again exposed.

The village of Pillkoppen has had a remarkable fate. The inhabitants left the place about the middle of the last century, and founded New Pillkoppen, at about a mile away. Then the dune went on in an unanticipated course, and old Pillkoppen has risen anew since the third decade of the present century; but the sand is already again a foot high in the potato-garden of the new school-house.

A fine wood near Schwarzort has been almost systematically destroyed by a dune advancing toward the southeast. It was composed of primitive oaks, lindens, and firs, and was in the year 1800 about five kilometres long, while now the dune has hardly left a kilometre and a half of it. Schumann says of this wood that "in about ten years after the tree has gone into the southern side of the moving dune, it emerges again from the north side. But the boughs which have been dried out and withered up during the interval are broken, ground up, and reduced to atoms as soon as the sand has left them. The same occurs later to the rotted stems. Few of these trees show more than an inch over the surface of the sand; and it is only the thicker and hardier trunks that can maintain themselves so as to project from two to five metres over the diminished dune. With most of them the sap-wood disappears down to the surface, the bark with all, which, however, is still present beneath. Frequently, the bark alone is left, while the wood has rotted away. Such trees are marked only by a hardly perceptible bark-ring, and the careless traveler is in danger of falling into the holes they have left." The time may be fixed with an approach to accuracy when the whole wood shall have been destroyed, and Schwarzort itself will be threatened. Schumann estimates the yearly progress of the dune at twelve metres, and gives the last trees still eighty years before they shall be overwhelmed.

In the small islands west of Jutland, the progress of the dunes is illustrated by a diminution of the islands themselves. For the sea eats the shore away year by year as it is left bare, and when the dunes have marched over the whole islands, and precipitated themselves on the eastern side of them into the sea, the islands will

have disappeared, and ships will find free sailing-ground where men are now living and cattle and sheep are pasturing.

Of course, man struggles to defend himself against this enemy. The only way of counteracting its movements is to cover the sand with vegetation and make it inaccessible to the attacks of the wind, and this is not very easily accomplished. The sand consists chiefly—seventy-five to ninety-eight per cent—of uncultivable quartz sand, in which only easily satisfied plants can be made to grow. The wind is, besides, sometimes so strong on the sea-coast as to permit lowly plants to grow only with difficulty, and trees not at all. Sand is, moreover, so fugitive a substance that plants are liable to be torn from it before they have taken firm root. But these hindrances can be overcome, though with difficulty. One of the first instances in which a sand mass was thus tamed was in Denmark in 1738. The sands of the Landes in France have been bound with entire success. Measures of precaution were undertaken in the neighborhood of Dantzic about the middle of the last century. As everywhere else on the Baltic, the dunes had been covered by Nature, except on the side toward the sea, with firs and bushes of all sorts, and thereby protected against the wind. But the ignorant greed of men had removed the wood, grubbed up the stumps, allowed cattle to tread the heaths at will, and treated the dunes so recklessly that their protective covering disappeared, and their sand masses were exposed to the winds. Consequently, at the beginning of the eighteenth century the villages of Kleinvogler and Schmergrube were wholly and Polski partly overwhelmed. It was not till about the middle of the century, when the dunes nearer to Dantzic began to encroach upon the fir-wood appertaining to the city, that measures of protection were thought of. The first measure suggested was the planting of fences of fir-boughs on the comb of the dune, to intercept the sand brought by the wind. This scheme failed. The deposits of sand in front and rear of the hedges made the constant planting of new barriers over the old ones necessary; and the dune increased in height at an alarming rate, involving a great danger of the sudden breaking down of the ridge, when the destruction effected by the sand would be worse than if it had been let alone.

In this dilemma, the Natural History Society of Dantzic, in 1768, offered a prize for the best answer to the question, "What are the most effective and cheapest means of preventing the overflow of the lowlands with sand, and of stopping the further growth of the dunes?" Titius, Professor of Natural History in Wittenberg, gained the prize, by an essay in which he indicated the restoration of the coast-woods as the only permanent remedy, and the planting of a sand-grass (*Arundo arenaria*) as the measure with which the immediate emergency might be met. His sug-

gestion was not carried out. But when Dantzic became part of Prussia, in 1793, the Government took the matter energetically in hand. Burgher Sören-Biörn, who was of Danish birth, recommended the application of Titius's plan, and was intrusted with the redemption of one of the most threatening dunes. Having accomplished this work to the general satisfaction, he was made inspector of plantations, and in this capacity superintended the work till his death in 1819.

Since then, the work of fixing the drift-sands has been begun in several places. As a generally approved preliminary measure, a fore-dune is first formed. This is done by planting between the dune and the sea two parallel fences, about six feet apart, and rising some eight feet above the level of the sea. These structures weaken the force of the sea-winds so much as to cause a considerable proportion of the sand to fall between them, or on either side of them. Thus a dune is formed. It is secured by planting several rows of *Arundo arenaria*—a grass that can not be buried by sand, because the more it is covered the better it flourishes, throwing out strong roots from below, and even growing in length above. The fore-dune protects the real dune against waves during storms, against a part of the wind, and against a continued overflow of new sand. Time is also gained for providing a covering of plants. First the sand-grasses are planted, then herbage-plants, then heaths and willows, and finally, in the least protected places, trees, of which firs are preferred.

The cultivation of the inland drift-sand is somewhat easier; but in either case it requires continuous, active work. Seeds of suitable sand-plants are sown and covered with limbs, straw, etc., till the resultant growth has become strong enough to stand against the wind. The ground is gradually improved by means of these plants, till at a later period useful plants can be cultivated, and the former desert can be turned into tillable land or wood. The conversion is, indeed, a tedious process, but the result is profitable.—*Translated for the Popular Science Monthly from Das Ausland.*

THE people of New Zealand are proud of the assiduity with which science is cultivated in that colony, and of its scientific literature. The New Zealand Institute is helped by a government grant. Under the provision of its act of incorporation, that any local society having fifty members can claim the right of affiliation with it, and of participation in its funds and privileges, the various scientific circles have been brought into communication with one another, and a friendly rivalry has been promoted. The twenty volumes of the "Transactions and Proceedings" of the Institute are filled with valuable memoirs on almost every scientific subject. A number of "Students' Manuals," issued at moderate cost, have had a salutary influence in interesting the young in science.

THE FUTURE OF THE NEGRO.

IT is difficult for men who study history to read the discussion now raging on the progress of Islam in Africa without recurring to the old question—which so greatly interested the last generation, and is now so seldom started—the question of what the negro is really like. There are not many left among us, we imagine, though there are some here and there, who doubt whether he is a man at all; but the conflict of opinion about him is of the most extreme kind, so extreme as to be almost unintelligible. One set of observers, with whom Captain Burton, as we understand his writings, agrees in the main, hold that he is a nearly irreclaimable savage, a being who can not be ruled except by terror, and who is by nature incapable of rising to the level attained by the white, and even in many respects by the yellow and the brownish man. They think his savagery instinctive, his laziness incurable, and his sensuality far in excess of anything observable in Europe. They declare Africa an accursed continent chiefly because of the negro, and welcome frightful narratives, like Mr. St. John's account of Hayti, as demonstrating past all question the accuracy of their theory. Other observers, again, including many missionaries and some explorers, are friendly to the negro, think that the repulsion caused by his external aspect makes ordinary men unjust to him, and declare that he is, when not oppressed, essentially a docile creature indisposed to vindictiveness, and, though not clever, fairly ready to receive instruction, which, they further add, may occasionally be carried up to any point attainable by the white man. Such observers, among whom we should class keen-eyed Mrs. Trollope, who had rare opportunities of studying the race, and keener-eyed Mrs. Stowe, think the Uncle-Tom kind of negro not rare, and evidently hold that when bad, he is vicious as a European may be, rather than innately savage. A third class maintain that the negro, if carefully observed, is found to be exactly like everybody else, with the same passions, the same aspirations, and the same powers, with one most remarkable exception. He can not rise in the scale beyond a certain point. The originating power of the European and the imitating power of the modern Asiatic are not in him, or not in the same degree; and he remains under all circumstances more or less of a child, bad or good like other children, but never quite a man. It is added by this class, and in part by the one mentioned before it, that the negro woman is, on the whole, better than the negro man, with more industry, more fidelity, and decidedly more capacity for the gentler virtues. The third opinion is, so far as we know, that of the majority of missionaries, of most residents in the West Indies not being em-

ployers of labor, and of all Americans, and they have been many, to whom we have opened the subject. Americans seem to us, as a rule, to think most kindly of the negro, to be entirely free from fear of him, to be annoyed with oppression practiced on him, but to be quite hopeless about his future. He will not advance, they think, and would recede but for the white man.

History certainly bears these Americans out. Throughout its whole course, in the Old World as in the modern one, under the most extreme variety of circumstances, no negro of the full blood has ever risen to first-class eminence among mankind. Not only has there been no negro philosopher, or inventor, or artist, or builder; but there has been no negro conqueror, nor, unless we class Said, Mohammed's slave, as one, and Toussaint l'Ouverture as another, any negro general above the rank of a guerrilla chief. There seems to be no reason for this except race. People talk of the seclusion of the negro: but he has always been in contact on the Nile with the Egyptian, or the Greek, or the Roman, in South America with the Spaniard, and in North America with the English-speaking Teuton, and he has learned very little. It is objected that he has been always a slave; but so was everybody else in the Roman period, most modern Italians, for example, being the descendants of the white slaves of the Roman gentry. Moreover, why does the negro put up with that position, when the Chinaman, and the red Indian, and even the native of India will not? It is said that he has been buried in the most "massive" of the four continents, and has been, so to speak, lost to humanity; but he was always on the Nile, the immediate road to the Mediterranean, and in West and East Africa he was on the sea. Africa is probably more fertile, and almost certainly richer, than Asia, and is pierced by rivers as mighty, and some of them at least as navigable. What could a singularly healthy race, armed with a constitution which resists the sun and defies malaria, wish for better than to be seated on the Nile, or the Congo, or the Niger, in numbers amply sufficient to execute any needed work, from the cutting of forests and the making of roads up to the building of cities? How was the negro more secluded than the Peruvian; or why was he "shut up" worse than the Tartar of Samarcand, who one day shook himself, gave up all tribal feuds, and from the sea of Okhotsk to the Baltic, and southward to the Nerbudda, mastered the world? One Tartar family was reigning at one time over China, Tartary, India, and Russia. Why has the negro, who is brave as man may be, alone of mankind never emerged from his jungles, and subdued neighboring races? Why has he never invented a creed of the slightest spiritual or moral merit, never, in fact, risen above fetichism? Above all, why has he remained in Africa, for three thousand years at least, without

forming empires or building stone cities, or employing a common medium of intercommunication? Mr. Blyden says he has formed cities full of busy life and commerce; but have they ever been better than encampments, and why have they not lasted? We who write certainly do not believe in the incurable incapacity of the race, for we know of Bishop Crowther and Mr. Blyden, and have talked with negroes apparently as thoughtful and as well instructed as any Europeans; but we confess that the history of the race remains to us an insoluble puzzle, except upon the theory that there are breeds of mankind in whom that strangest of all phenomena, the arrestment of development, occurs at a very early stage. The negro went by himself far beyond the Australian savage. He learned the uses of fire, the fact that sown grain will grow, the value of shelter, the use of the bow and the canoe, and the good of clothes; but there to all appearance he stopped, unable, until stimulated by another race like the Arab, to advance a step. He did not die, like the Australian. He did not sink, like one or two varieties of the red Indian, and of the aborigines of South Africa, into a puny being hardly like a man; but he stopped at a point as if arrested by a divine will. There is not a shadow of proof that the negro described by Werne differs in any way from the negro of the time of Sesostris. It is not quite certain even that the race, when started again, would, as a race, go on improving. The Haytians, who are Christians, who are free, and who are in the fullest contact with great white races, are believed to be retrograding; and only the hopeful would believe in the future of American slaves, if they were to be expelled, as De Tocqueville thought they would ultimately be, to the islands, or, as is infinitely more probable, should the war of races ever break out, to Central America.

As far as we see, nothing really improves the negro except one of two causes—cross-breeding, and catching hold of some foreign but superior creed. The cross-breeds of the Soudan and of South Africa seem to have some fine qualities—matchless courage, for example—and under a strict but vivifying white rule might, we fancy, be brought in a century or two up to the Asiatic level. They produce generals, at all events, and chiefs with some tincture of statesmanship, and have poetry and a folk-lore of their own. Those negroes, again, who have embraced Islam do show a certain manliness, a capacity for aggregation, and a tendency, at all events, to form kingdoms, and organize armies, and obey laws, which are the first steps toward a higher civilization. It is not a high civilization, for, when all is said, a Mohammedan negro is not an ideal of humanity toward which Europeans can look with any feeling of enthusiasm; but still, it is higher, far higher, than the condition of the African pagan. The negro who embraces

Christianity, again, while he remains in contact with the white man distinctly advances. "Uncle Tom" is an abnormal specimen, it may be, and we are not inclined to place the moral condition of the negroes of the Southern States very high; but still, they have displayed a perfectly wonderful absence of vindictiveness toward the former slave-owners, obey the ordinary laws with fair regularity, and keep themselves above starvation by the labor of their own hands. The best of them, moreover, rise far beyond this point, the South containing both doctors and lawyers who, by the admission of the whites, are thoroughly competent men; and it may be said of the whole body that, though not equal to any European community of the same extent, they are far superior to any four millions of pagan negroes who could be selected in Africa. As they can not owe this rise in the scale to slavery, which at the best could only drill the negroes to industry, and at the worst must beget a permanent distaste for labor, the change must be owing to Christianity, plus the operation of laws based upon that faith. It follows that the largest group of negroes under civilized observation, the descendants, as is believed, of four widely distinguished tribes, have been raised in the scale of humanity by embracing a rude form of the Christian faith. The total conclusion, therefore, as yet justified by evidence, is that intermarriage, especially with the Arab, improves the negro tribes, that they gain in manliness by embracing Islam, and that they gain in the social virtues by embracing Christianity, the latter to a degree measured by the depth and earnestness of their faith. At home, when unconquered and unconverted, they do not advance, and the point still doubtful is whether, when left to themselves, they will not, even when converted, again recede or stop. The Abyssinians, who are Semites, have been Christians for ages. The conclusion is not very satisfactory; but it is certain that races of imperfect powers exist—e. g., the Australian aborigines—and that Providence does, for unknown purposes, occasionally waste even fine races—e. g., the Maoris—who will, to all appearance, die out, having fulfilled no function at all, not even that of preparing the way for the ultimate occupants of their country.—*Spectator.*

A CURIOUS economical study is afforded by the four groups of the Scilly Islands and Orkneys—which are as a rule prosperous—and the Western Hebrides and Shetland Islands—which are miserable—under similar outward conditions and surroundings. Those conditions and the rule of race failing to account for the difference, Mr. T. H. Farrer suggests that the explanation may be found in the fact that in Scilly and Orkney the industries by which men live "have become separated, specialized, and perfected, each practiced and developed by separate classes as a separate pursuit," while in the Hebrides and the Shetlands the crofter has to be at the same time a kind of Jack at all trades.

SKETCH OF SPENCER F. BAIRD.

IN Prof. Baird we have a conspicuous example of a man who cultivated science for itself alone. While in no sense careless of his own fame, he was always willing to prefer to it the advance of knowledge; was ready to rejoice at every new contribution, though it might tend to forestall something of his own; and was often willing to aid constructive rivals, as is expressed in one of the tributes brought out by his death, by access to his own papers and workings, at the expense of his own priority in the same field. Of another trait of his scientific character Major Powell says, "Baird was one of the learned men of the world, and to a degree perhaps unexampled in history he was the discoverer of the knowledge he possessed."

SPENCER FULLERTON BAIRD was born in Reading, Pa., February 3, 1823, and died at Wood's Holl, Mass., August 19, 1887. He was of English, Scotch, and German descent, his paternal grandfather having been of Scotch parentage, and his ancestry on the mother's side English and German. One of his great-grandfathers was the Rev. Elihu Spencer, one of the war preachers of the Revolution, on whose head a price was set by the British Government. His father, Samuel Baird, was a lawyer in Reading, who is described as having been "a man of fine culture, a strong thinker, a close observer, and a lover of Nature and of out-of-door pursuits." He died when the son was ten years old. Spencer was sent in 1834 to a Quaker boarding-school, kept by Dr. McGraw, at Port Deposit, Md., and in the next year to the Reading Grammar School, and in 1836 he entered Dickinson College, whence he was graduated when seventeen years old. His tastes for natural history and collecting were developed early, and were shared by his elder brother, William M. Baird, whose companion he became in collecting specimens of the game-birds of Cumberland County, which the elder brother had undertaken in 1836. Six years later they published conjointly a paper describing two species, supposed to be new, of the genus *Tyrannula*, Swainson. A number of specimens, fruits of their joint work, are now to be seen in the National Museum at Washington. He pursued his studies in general natural history in the field for several years after leaving college, making long pedestrian excursions for observation and collection, and organizing a private cabinet, which became the nucleus of the Smithsonian collections. In 1841, when eighteen years old, he made an ornithological excursion through the mountains of Pennsylvania, walking four hundred miles in twenty-one days, and the last day sixty miles. In the following year he walked more than two thousand two

hundred miles. He unquestionably derived much benefit in his studies from his intercourse with Audubon, which began in 1838. He contributed many facts and specimens for the "History of North American Quadrupeds" and the "Ornithological Biography." Audubon gave him a considerable part of his collection of birds. He had intended to accompany Audubon as his secretary in his six months' expedition to the Yellowstone in 1840, but was prevented by ill-health.

He read medicine, and attended a winter course of lectures at the College of Physicians and Surgeons in 1842; but he never formally completed the course, and the degree which he received in 1848 from the Philadelphia Medical College was an honorary one. In 1845 he was made Professor of Natural History in Dickinson College, to which chair Chemistry was afterward added. In this position—teaching the seniors in physiology, the sophomores in geometry, and the freshmen in zoölogy—he also found time to keep up his scientific researches, and to make long collecting expeditions to the Adirondacks in 1847; to Ohio in 1848, for the collection of types of the fishes of the State; to the mountains of Virginia in 1849; and to Lake Champlain and Lake Ontario in 1850. "In his own collections during this period," says the author of a tribute in "The Nation," "were developed those business-like methods of arrangement and detail for facilitating study which were subsequently adopted and extended, not only in the institutions which grew up under his supervision, but by nearly all other American scientific museums, and which form a system that for usefulness and efficiency has no parallel in any foreign museum up to the present moment."

In 1850 Prof. Baird was appointed, upon the recommendation of the Hon. George P. Marsh, assistant secretary of the Smithsonian Institution. In this position he was brought into immediate relations with Prof. Henry, under whose inspiration the institution was just getting fully under way. It was the ambition of that chief to make the influence of the institution diffusive rather than concentrative. It was to be the depository of all the collections which should come into the hands of the Government. Prof. Henry would not have it to monopolize these collections or be so managed that only those might enjoy the advantages to be derived from their study who should be immediately connected with it; but he considered that, while in the study of the specimens and the publication and dissemination of the results it might properly join forces with the Government and with private persons, its part of the labor and expense should be as purely supplementary to other agencies as circumstances might permit. "The policy of the institution under Henry was to disperse as widely and freely as possible the worked-up material, and to enlist in the process of

elaboration the aid and enthusiasm of every American naturalist, each in his own field." To make this policy a success, such as it eventually became, continues the author of the tribute in "The Nation," "required qualifications of no ordinary kind. Not only must the work of mediation be guided by the most advanced biological science of the time, but the individual intrusted with it must possess a spirit of impartial liberality, tempered by a sound discretion in business methods, a thorough knowledge and just estimate of men, an untiring patience to meet the peculiarities and caprices of the independent and often one-sided specialists whose co-operation was essential, a geniality to enlist the willing but unscientific collaborator, and an instant detection of humbug in every guise. Providentially for the future of natural science in this country, the need and the man met in the selection of Prof. Baird. In qualifications for the work, he stood pre-eminent —a head and shoulders above any man of his time, and perhaps above all other scientific men of any time."

When Prof. Henry died in 1878, the choice of Prof. Baird to succeed him as secretary of the institution was almost a matter of course, and it is superfluous to say that his designation to that position was by the unanimous vote of the board of regents.

It is worthy of note in connection with the record of Prof. Baird's work in the Smithsonian Institution that the first grant made by the Institution for scientific exploration and field research was in 1848, "to Spencer F. Baird, of Carlisle, for the exploration of the bone caves and the local natural history of southeastern Pennsylvania." "This transaction," says Mr. William B. Taylor, in a memorial address, "appears to have been the occasion of first bringing the young professor to the favorable notice of the Smithsonian director, Prof. Henry, and of initiating between the two a mutual respect and friendship that continued throughout their several lives." Prof. Baird had the charge of the department of explorations, of his work in connection with which, Prof. Goode says that, "in his reports to the secretary, published year by year in the annual report of the Institution, may be found the only systematic record of Government explorations which has ever been prepared. From 1850 to 1860 several extensive Government expeditions were sent to the Western Territories, and it became the duty of Prof. Baird to enlist the sympathies of the commanders of these expeditions in the objects of the Institution, to supply them with all the appliances for collecting, as well as with instructions for their use, and also, in most cases, to organize the natural history parties, nominate the collectors, employ and supervise the artists in preparing the plates, and, in many instances, to edit the zoölogical portions of the reports. The fitting out of such expeditions was only a small part of the work; from the

beginning until now there have been numerous private collections, deriving their materials, their literature, and, to a considerable extent, their enthusiasm from the Smithsonian Institution, and consequently in correspondence with its officers. The Smithsonian 'Instructions to Collectors,' which has passed through several large editions, as well as numerous circulars written with a similar purpose, were prepared by Prof. Baird in connection with this department of his work. As a result of this extensive work of organization, a large number of young men have been trained as collectors and observers, and not a few among them have become eminent in various departments of science. In addition to this extensive branch of his work, the assistant secretary had, from the start, the charge of certain departments of the routine work of the Institution; the system of international exchanges, for instance, which had ever been one of the leading objects of the Smithsonian Institution, was organized by him in its details." Major Powell, speaking of the comprehensiveness of his methods for enlisting co-operation in these enterprises, says: "When our army was distributed on the frontiers of the land, he everywhere enlisted our scholarly officers into the service of science, and he transformed the military post into a station of research, an Indian campaign into a scientific expedition. Scott, Marcy, McClellan, Thomas, and many other of the great generals of America, were students of natural history and collectors for Baird. When our navy cruised around our shores, its officers were inspired with that love of Nature which made every voyage of military duty a voyage of discovery in the realms of natural science." Explorations, railroad-surveys, and travels throughout the world, were thus utilized by him in the interests of science. The main duty of the assistant secretary, however, was the development of the natural-history collections. Prof. Baird had brought his private collection to form a nucleus around which the others should be gathered. The Institution was in the possession of a few boxes of minerals and plants; and the collections of the Wilkes Exploring Expedition were under the charge of the National Institute, to be ultimately, as was provided in the act of incorporation of the Smithsonian Institution, transferred to it. To the care of these collections, and the management of the National Museum which has grown up from them, Prof. Baird brought the methods of work which had been developed in his own experience at Carlisle; and these methods are substantially those on which the museum is organized and conducted to-day. His faithful attention to the arduous duties of his position here did not prevent his publishing a considerable number of elaborate original memoirs, among which were a catalogue of North American serpents, the "Mammals of North America," and three

works on birds, in one of which Thomas M. Brewer and Robert Ridgway were his collaborators; the scientific departments of the Harpers' periodicals; and numerous official reports.

The office of Commissioner of Fish and Fisheries was instituted, without salary, in 1874, with the attendant duties of inquiring into the decline of valuable fisheries on the coast and lakes of the United States, investigating its causes, and seeking for measures to prevent it and to restore the supply of food-fishes. Prof. Baird was appointed to this office. Under his direction it grew yearly in importance, and made the results of its work more widely and directly felt in all parts of the United States. An impulse was communicated by its workings to the efforts of the several States in caring for their fish-supplies, which became more systematic and regular; and the effects of its labors are now palpable in all parts of the Union in the restocking of our rivers and ponds, which has been to a large extent practically effected through the co-operation of the Commissioner's industrious assistants and the State and local authorities. Its work, according to Prof. G. Brown Goode, is naturally divided into three sections: The systematic investigation of the waters of the United States, and the biological and physical problems which they present—in which Prof. Baird included not only the life-histories of species of economic value, but also the histories of the animals and plants on which they feed or on which their food is nourished, the histories of their enemies and friends, and of the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth; the investigation of the methods of fishing, past and present, and the statistics of production and commerce of fishery products, with particular attention to the influence of man upon their abundance; and the introduction and multiplication of useful food-fishes throughout the country, especially in waters under the jurisdiction of the General Government, or those common to several States, none of which might feel willing to make expenditures for the benefit of the others. The published reports of this commission, which seem to grow in volume every year, form extensive treasuries of knowledge on every subject which can be referred to these three headings. By means of these reports, and his various articles bearing on ichthyology, he was instrumental, according to Mr. W. H. Dall, "in bringing together for the use and benefit of the English-speaking public the largest body of facts relating to fish and fisheries ever prepared and digested for such purposes by any individual or organization. Recognized by experts of foreign countries with one accord as the most eminent living authority on economic ichthyology, America owes to his fostering care and unwearied

labor the existence of a whole generation of ichthyologists, breeders of fishes, and inventors of appliances of all sorts for use in connection with the taking, preservation, and increase of these animals. . . . Whether germane to the subject of scientific research or not, the most narrow specialist can hardly judge an allusion to the grandeur of the methods by which the food-supply of a nation was provided, hundreds of rivers stocked with fish, and the very depths of the ocean were repopulated. . . . In a few years we may fairly expect to see the food-supply of the entire civilized world materially increased, with all the benefits which that implies, and this result will in the main be owing to the unremunerated and devoted exertions of Spencer F. Baird."

As estimated by Mr. Dall, the proportion of the vertebrate fauna first made known by Baird to the total number recognized at the time as North American, varied from twenty-two per cent of the whole to forty per cent in different groups. His method of study of new material was as far removed as possible from bookishness. Prof. Baird's early life, Mr. Dall adds, "had included so much of exercise in the shape of long pedestrian journeys with gun and game-bag, so much familiarity with the wood-life of his favorite birds and mammals, that it would have been in any case impossible to class him with the closet-naturalist; while to this knowledge he added a genius for thorough, patient, and exhaustive research into all which concerned the subject of his study, and a wonderful inventiveness in labor-saving devices for labeling, museum-work, and registration. He had a wonderful capacity for work." These qualities, and others consonant with them, enabled him to draw conclusions which subsequent accumulations of material have verified in a surprising manner.

Prof. Baird was a man of great literary activity. The number of his works and contributions down to the end of 1882, recorded in Prof. G. Brown Goode's "Bibliography," is 1,063, of which, however, 775 are brief notices and critical reviews contributed to "The Annual Record of Science and Industry," 31 reports relating to the work of the Smithsonian Institution, 7 reports upon the American fisheries, 25 schedules and circulars officially issued, and 25 are volumes or papers edited; but many of these papers also contain important original matter. Of the remaining 200 papers, the majority are formal contributions to scientific literature. Some 20 or more of the papers were prepared conjointly with some other author—his brother, William M. Baird, Charles Girard, Messrs. Cassin and Lawrence, or Messrs. Brewer and Ridgway. Of all the papers, 73 relate to mammals, 80 to birds, 43 to reptiles, 431 to fishes, 61 to invertebrates, 16 to plants, 88 to geographical distribution, 46 to geology, mineralogy, and paleontology, 45 to anthropology, 31 to industry and art, and 109 to ex-

ploration and travel. In them all, 361 new species are described. The earliest contribution in the list is the description of two new species of the genus *Tyrannula,* Swainson (1843), which he prepared in conjunction with his brother. An application of bichromate of potassa to photographic purposes, published in 1844, was employed by him in taking leaf photographs, a collection of which, preserved in the National Museum, has been one of the standard resources of American palæophytologists, and has been used in the preparation of many of the works on the fossil botany of the United States. In a "Summary of Suggestions in Regard to Future Operations of the Smithsonian Institution in the Department of Natural History" (1851), the purpose is outlined not to attempt collections of all natural objects, but rather to gather up such materials for investigation as have been comparatively neglected by others. In the same paper occurs a statement in reference to Japan which sounds curiously now when the activity and co-operation of the Japanese in scientific matters are so conspicuous. After speaking of Japan as a region in some respects more closely allied to our country than even Europe, the author remarks: "Unfortunately, there are at the present time almost insuperable difficulties in the way of procuring Japanese specimens, the Dutch naturalists being the only ones who have succeeded in exploring even the shores of this country. Little can be done, therefore, except by exchange with the museums of Holland." In 1851 he translated from the German and edited the "Iconographic Encyclopædia," an elaborately illustrated dictionary of physical facts and art, of unquestioned merit, which had great currency till it was superseded by later works reflecting the progress of science. The volume on "Birds," in the series of the Reports of the Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean (1858), was prepared by Prof. Baird, with the co-operation of John Cassin and George N. Lawrence. Prof. Coues says, respecting it, that "the appearance of so great a work, from the hands of a most methodical, learned, and sagacious naturalist, aided by two of the leading ornithologists of America, exerted an influence perhaps stronger and more widely felt than that of any of its predecessors, Audubon's and Wilson's not excepted, and marked an epoch in the history of American ornithology. . . . Such a monument of original research is like to remain for an indefinite period a source of inspiration to lesser writers, while its authority as a work of reference will always endure." "The Annual Record of Science and Industry," which was published for several years under Prof. Baird's editorial supervision, was made up from the items and articles that had been published during the year in the Harpers' weekly and monthly periodicals. Many of them were original

contributions to knowledge, never elsewhere published. Others were critical reviews or notes upon the current literature of science. Others are abstracts of scientific papers, with the addition of explanatory or illustrative remarks. Others still are abstracts of papers for the most part in the words of the authors of the papers or of some other reviewer. A modification of the plan of the "Record" was introduced in 1877, under which, instead of merely general summaries of progress in various branches, with abstracts of papers, more space was given to the former part, and the summaries were prepared by eminent specialists, and published under their names.

A beautiful picture of Prof. Baird's personal character and of his unselfish devotion to science is given in the tribute which was published in "The Nation." In selecting men for particular positions or lines of work, "he was very rarely mistaken in his judgment. In his position he was called upon to advise in nearly all Government appointments which had a scientific bearing, direct or indirect, and the total number of selections which he determined during his career must have been many hundreds, and have included nearly every available person among the younger generation of students. The most surprising element in it all, to those cognizant of the details, was the calm impartiality which he brought to the task. No thought of self seemed to enter into his calculations. . . . It is evident that, in promoting the studies of others, and in holding as a trust for the general benefit the vast collections which passed under his control, opportunities must have been numerous for giving precedence to the progress of his own researches rather than of those of others engaged in the same lines. In such cases, we believe, he never hesitated, and the decision against himself was in more than one instance known by him at the time to be of pecuniary as well as of scientific disadvantage to his own interests. He never spoke of this sort of self-denial, and it was in a majority of cases known but to a few persons incidentally connected with the researches in question. . . . Two things," the author of the tribute says in conclusion, "his experiences may be said to have lacked—he never had a personal controversy, nor, so far as we have ever heard or had reason to suspect, an avowed enemy."

In illustration of his modesty, which amounted almost to timidity, and was yet so engaging as to secure him advocates whenever he presented his views, Mr. Garrick Mallery relates that he once joined Prof. Baird on his way to a meeting of the Philosophical Society of Washington, where he was to deliver an address on a subject connected with fish propagation. During the walk, says Mr. Mallery, "he spoke of the struggle at that moment between the sense of duty requiring him to take part in the pro-

ceedings of the society, and his reluctance to making any formal address. This modesty—indeed, timidity—in an eminent writer and thinker whose lightest words were sure of eager attention in a society composed mainly of his personal friends and wholly of his admirers, was the more remarkable because his address, presented a few minutes later, was most pleasing in its delivery as well as instructive in its substance.

About a year before his death, Prof. Baird was informed by his medical adviser that complete rest from mental exertion was necessary to the restoration of his nervous energies. He accordingly obtained the appointment of two assistants to relieve him of the burden of his cares, and sought the recuperation which he needed. In the summer of 1887 he returned to his work by the sea-side, to Wood's Holl, where he had created the greatest biological laboratory in the world; and in that laboratory, says Major Powell, "with the best results of his life-work all about him, he calmly and philosophically waited for the time of times. Thursday, before he died, he asked to be placed in a chair provided with wheels. On this he was moved around the pier, past the vessels which he had built for the research, and through the laboratory, where many men were at work at their biologic investigations. For every one he had a word of good cheer, though he knew it was his last. At the same time, along the pier and through the laboratory, a little child was wheeled. 'We are rivals,' he said, 'but I think that I am the bigger baby.'" Then he was carried to his chamber, where he soon became insensible.

Of the honors given to Prof. Baird, besides the usual supplementary college degrees conferred by Dickinson College and Columbian University, he was awarded the silver medal of the Acclimatization Society of Melbourne, the gold medal of the Société d'Acclimatation of France, the first honor-prize (the gift of the Emperor of Germany) of the Internationale Fischerei Ausstellung at Berlin, and the decoration of the Royal Norwegian Order of St. Olaf. He was a member of the council of the National Academy of Sciences, was permanent secretary of the American Association in 1850 and 1851, was trustee of the Corcoran Art Gallery, president of the Cosmos Club, a trustee of Columbian University, and a member of the Historical Society of New York. Among foreign societies in which he held honorary or other memberships, were the Linnæan and Zoölogical Societies of London, the Linnæan Society of New South Wales, the New Zealand Institute, the Geographical Society of Quebec, and Royal or other scientific societies in Vienna, Lisbon, Batavia, Buda-Pesth, Cherbourg, Jena, Halle, Nuremberg, and Berlin. More than twenty-five species and one genus in zoölogy, and a post-office in Shasta County, Cal., bear his name.

CORRESPONDENCE.

THE COTTON-STRING CURE.

Editor Popular Science Monthly:

SIR: Last October an article appeared in your "Monthly" entitled "Strange Medicines," by Miss C. F. Gordon Cumming. To her very interesting list I would like to add a strange remedy, or method of cure, which has come to my knowledge since reading the above-mentioned article. To this day, in some parts of Indiana, there is practiced what is called "*measuring*" for "*flesh-decay.*" As far as my information goes, this remedy is only applied to infants. By "flesh-decay" is meant the pining or wasting away sometimes noticed in babies—who, for no very apparent reason, become fretful, thin, and puling. In such cases, in regions where the superstition I am trying to describe prevails, instead of calling in a regular physician, some old or middle-aged woman is sent for to "measure" the sick child. The process is performed thus: The baby is undressed and laid flat on a bed, as flat and straight as possible; then any common cotton string is taken in the hands of the performer, and carefully and accurately, from the crown of its head to the soles of its feet, the string is stretched over the body, to ascertain its exact length. This length is cut off and given the parents of the child, who are told to bury it in the earth in some obscure corner; and the belief is that when that string begins to decay, the child will begin to recover. My informant, who recently came to this State from Indiana, has seen this done, and knows of its being done many times. I can not find out how the supposed gift to cure thus comes to be credited to certain persons. As far as the observation of my informant went, in cases where the "measuring" process was used to cure "flesh-decay," the sick child, when it did begin to improve, began to do so much sooner than the buried cotton string would have in all probability begun to decay. That babies sometimes took a decided turn for the better after the "measuring" process can, it seems to me, be accounted for in this way: Sick people, and especially children, are, by the most eminent physicians and experienced nurses, recognized to be very susceptible to the feelings of those around them: i. e., if those around are very anxious and discouraged about their condition, it has a depressing influence on the invalid; whereas an atmosphere of cheerfulness and hope helps them to recover. In the above case, the parents and relatives of the sick baby who has been "measured," having perfect faith in the efficacy of the cure, would, after the performance, surround the little sufferer with an atmosphere more favorable to its recovery. Besides this, as near as I could find out, the persons used to wield this cotton-string cure were fat, motherly old dames, whose manipulations of the sick child while smoothing it out on the bed to get it straight, would be likely to have a soothing, revivifying effect. But I am here entering on that mystic theme, the relations of mind to matter, which I feel far too unlearned to discuss. Yours truly,

MRS. A. J. TOWNER.

SANTA ANA, CAL., *April* 17, 1888.

THE DEMAND FOR SCIENTIFIC BOOKS IN CHINA.

Editor Popular Science Monthly:

SIR: Mathematics and astronomy have been somewhat successfully studied in China during two or three thousand years; but geography, geology, botany, zoölogy, human anatomy and physiology, chemistry, and physics have been unknown in native literature. Many dreary volumes have been written, by Chinese authors, upon plants, animals, and ethnology, with curious myths, fables, and superstitions set forth as facts. In spite of the vast bulk of its pseudo-scientific literature, no true science can be said to have existed in China until it was introduced from the West, by the Jesuit missionaries, in the fifteenth century. Since that time, and especially during the last few decades, many books of European origin have been translated into Chinese, and a goodly number of volumes of a scientific and technical character have been prepared by Protestant and Catholic missionaries, and by foreigners in the service of the Chinese Government. The number of such books became considerable, but no organized system for their sale or distribution throughout the empire had existed until, in 1885, Mr. John Fryer, of the Kiangnan Arsenal in Shanghai, established, as an experimental and philanthropic undertaking, a Chinese "Scientific Book Depot," for the purpose of facilitating the spread of all useful literature in the native language. Elementary books on the various sciences studied in Western nations were offered for sale, with works on mechanics, engineering, surgery, therapeutics, and translations of Wheaton's "International Law" and Loomis's "Differential Calculus." The catalogue contained over two hundred scientific and educational treatises, translated or compiled and published in Chinese, under foreign management, with a selection of about two hundred and fifty sound and instructive works of native origin. The price of the books ranged between two cents and sixteen

dollars, the average being ten cents. During the first year the expenses of the "Scientific Book Depot" were covered by the profits on the sale of four thousand five hundred dollars' worth of books, maps, and charts. During the second year branch depots were opened at Tientsin, Hangchow, and Swatow, and the total sales for the year amounted to six thousand dollars. During the third year depots were added at Pekin, Hankow, Foochow, and Amoy, and the sales of books largely increased, so that about seventeen thousand dollars' worth of books had been sold by the end of 1887, and some of them had found their way to the most distant parts of China, and also to Corea and Japan. At least a hundred and fifty thousand volumes of this scientific and educational literature had been disposed of, in addition to considerable numbers of maps and charts.

The demand for Western learning has been greatly augmented during the last year by a remarkable change in the scheme of the competitive examinations whereby successful candidates for literary degrees obtain honors and offices. In the past, only a knowledge of the native classics, with skill in the use of the native hieroglyphics, has been required of the scholar. Now, geography and natural philosophy have been add.d to the subjects for examination, and this action of the Government has turned the attention of students throughout the empire in a new direction. The indications are that China is to follow Japan in the path of progress in Western science and philosophy, though it may be with the slow step that accords with the magnitude of the nation.

ADELE M. FIELD.

SWATOW, CHINA, *February*, 1888.

EDITOR'S TABLE.

CULTURE AND INTELLIGENCE.

THERE is a decided improvement in this country in favor of what is known as "culture." Between summer schools of philosophy, Chautauqua courses of study, and various other schemes of similar nature, we have an almost embarrassing choice of means for intellectual improvement. Young people all over the country are studying the great masterpieces of literature, ancient and modern. Now it is Dante, now it is Chaucer, now it is Victor Hugo. There is no doubt at all that this is useful work; at the same time there is just one caution, as it seems to us, to be given. In all this study what is supremely wanted is an objective point; otherwise we shall have, as the result of it all, a lot of people taking pride in their literary *bric-a-brac*, and yet with minds ill furnished for everyday purposes—destitute, that is to say, of a vigorous practical intelligence. We might, perhaps, without danger of falling into serious error, go so far as to say that some of the tasks prescribed by the organizations to which reference has been made are not in every case suited to the minds that attack them. A person of naturally comprehensive mind, capable of taking a wide survey of things, and with daily occupations that tend to promote mental balance, may undertake an exhaustive study of Dante without throwing the general structure of his or her thought and knowledge out of all symmetry; but we should not feel like guaranteeing an equally harmless result in the case of some of those whom we see bending over such tasks, and who, if they take possession of Dante in any real sense, will have something on hand out of all proportion to the volume and mass of all their other mental acquisitions put together. In cases such as we have in view there is just this alternative: Dante is either learned in some effective fashion, or he is not learned to any purpose worth mentioning. In the former case there ensues a certain lopsided development of culture, in the other we have a mind more or less spoiled by a mere show of knowledge and the affectations to which superficial acquisitions seldom fail to give rise.

The main point, however, to keep in view, and that toward which our caution is directed, is that all knowledge should be rated in exact proportion to the effect it has in promoting a sound

practical intelligence. In so far as the studies to which we refer make for intelligence in the true sense, they are to be commended and valued; but, in so far as they stand in the way of the acquisition of knowledge or of practical arts better adapted to develop the judgment, and in a general way to produce a robust intellectual constitution, they are to be deprecated. We are rather of opinion that the training which the majority of people chiefly require, is one that will enable them to pronounce sure judgments on questions of limited range, leading them on gradually to efforts of wider scope just as their knowledge and experience are enlarged. A lack of common sense goes very ill with pretensions to superior culture; yet the two are not unfrequently associated. A fine appreciation of Dante's poetry seems like misplaced intellectual luxury, when we find that the person possessing it is unable to say yes or no to some comparatively simple question, or unable to help himself or herself in some very slight intellectual difficulty, or to throw off the thralldom of silly and misleading phrases. "*C'est magnifique*," one is tempted to exclaim, "*mais ce n'est pas la vie!*" Splendid, no doubt, but not real life! We should, therefore, propose that those who engage in these fine studies—capable, under suitable conditions, of yielding most valuable results—should check their progress from week to week and month to month by asking, and trying to ascertain, whether their judgment is being developed, whether in the common things of life they are moving with a firmer step, whether they more readily put aside flimsy pretenses and specious seemings, and pierce more truly to the heart of the matters with which they have to deal. What we all want is better order in our daily thoughts, a clearer vision, a firmer courage. True culture of course implies progress in these directions; but much that passes for culture does little or nothing either for the mind or for the character. Much depends on the end we keep in view. If we study great authors for the sake of having, as it were, an elaborately furnished drawing-room in our minds, we shall get about the same amount of benefit as people commonly get from elaborate drawing-room furniture; but if we study them so as to gain a wider outlook on the world through understanding their thought and duly estimating the conditions under which they wrote—if, moreover, we prove ourselves from time to time, to see whether we are really gaining in mental power—the benefit to us may be very great. We rejoice at every sign of increasing intellectual activity throughout the country, and only ask that it may all be dominated by practical ends and made subservient, not to individual vanity, but to the best interests of American civilization.

EDUCATION NOT A FUNCTION OF THE STATE.

We noticed quite a ripple of discontent some time ago in educational quarters, particularly over certain remarks of ours tending to show that education was a matter for the family and for private co-operation, rather than for the state. One respected correspondent asked if we wished to deliver education over to the haphazard of private competition, and we replied by suggesting that there was rather more of haphazard in the politics that necessarily entered into state education than in the methods of the business world. Well, it so happens that public attention and criticism have lately been directed to the public-school system of our own highly-favored metropolis. And with what result? Why, that the system in question, which had often been lauded to the skies as a model of efficiency, as a shining example of what state authority, coupled with the taxing power, could effect in the field of education, has been found wanting at almost every point, vitiated through and

through by the methods of the politician, and half-strangled in the bonds of routine. So great has been the dissatisfaction—we might almost say, dismay—at the discovery, that we hear of the formation of a committee of citizens who propose to charge themselves with the duty of watching the action of our educational authorities, and, if possible, bring the working of the state machine into measurable accord with the reasonable demands of the community—demands predicated upon a knowledge of the results which well-directed private enterprise is made to yield. So, then, we first of all arm the state with full power for all purposes of public education, and then, when the business falls—as fall it must—into the hands of the politicians, and these proceed to act according to their natural instincts, we organize volunteer committees to infuse a little of the breath of life, a little of the vigor of private enterprise, a little of the true spirit of science into the unwieldy organization we have called into existence. We abandon private effort through a conviction that it will not meet the case, will not educate the people fast enough, and then we resort to it again in order to make the governmental machine move. Surely, under the circumstances, we are entitled to ask why private effort and enterprise should ever have been abandoned, why education should ever have been mixed up with politics at all. If we have so many prominent citizens prepared to act as a kind of Vigilance Committee to keep the politicians, to whose care our educational interests have been committed, from violating or mismanaging their trust, surely the same citizens might do much toward organizing a system of education for the people, and making it work for the general advantage. We know it is taken for granted to-day that parents will not pay, directly, for the education of their children. In less enlightened days they were prepared to do so, and to make considerable sacrifices for the purpose; but in these days, having tasted the sweets of free schools, they regard education as something which should not entail any visible or appreciable sacrifices. The assumption, no doubt, is largely based on fact, but can it be claimed that the change is a happy one? If not, if it is an unhappy one, can we too soon set about turning the current of people's feelings in another direction? We do not propose to discuss the question at any length at present, but merely wish to point to the fact, which recent events in this city have rendered notorious, that all is not for the best in the nominally and reputedly best possible system of education. Here, in New York, the system has, to a large extent, broken down. It is seen not to be a system of education in the true sense, but a system the main elements of which are political, and which, consequently, feels no impulsion toward improvement. The committee of citizens are no doubt armed with good intentions, and we highly applaud their action in coming forward at this juncture; but we fear their zeal will wane before the steady persistence of the enemy. To hand over education to the state is a step easier to take than to retrace; and the evils of the political management of education are very much easier to protest against than to cure.

LITERARY NOTICES.

A History of Political Economy. By J. K. Ingram, LL. D. With preface by Prof. E. J. James, Ph. D. New York: Macmillan & Co. Pp. 15 + 250. Price, $1.50.

The author of this book is the writer of the article "Political Economy" in the latest edition of the "Encyclopædia Britannica," and the book is, for the most part, a reproduction of that article. Prof. James, in his preface, characterizes the present treatise as "the first serious attempt by a properly qualified English writer to present a view of the progress of economic thought," and adds that it "will compare favorably with any

work of similar compass in any other language." The book is designed to aid the mode of studying this science which is insisted on by the so-called "historical school" of political economists lately arisen. It aims to trace the successive economic doctrines of the past, in connection with the conditions of the time in which each one appeared. Passing quickly over the economic thought of ancient and mediæval times, the author enters upon the modern period, which he divides into three phases. In the first phase, or during the fourteenth and fifteenth centuries, the "Catholico-feudal system" was breaking down, while a new order, the commercial, was rising beneath it. In the second phase, the collapse of the mediæval social structure is followed by the advance of the central government, which, while promoting the growth of commerce, levies tribute upon it to obtain the necessary supplies for military operations. The conditions of this time give rise to the "mercantile school" of political economy. In the last phase—during the eighteenth century—a spirit of individualism arose, and the dogma of *laissez faire* was received with general favor. This tendency, in the absence of the moral discipline partly established in the middle ages, led to the domination of national selfishness and private cupidity. But the rising elements—science and industry—are bringing with them a discipline more effective than the old, and the effort to press forward in the path which they point out gives the character to the period in which we live. The author then proceeds to indicate that the respective features of the second and third phases are reflected in the contemporary economic speculation; those of the first, he says, can scarcely be said to find an echo in any literature of the time. He gives an exposition of the mercantile doctrine, with comments on each important economic treatise which appeared during the prevalence of the tendencies which formed the mercantile school. In treating the doctrine of the third modern phase, or the system of natural liberty, the author takes up first the economic writers of France, Italy, Spain, and Germany before Adam Smith, and follows these with an extended review of Smith's teachings. The later economists of England and the Continent next receive attention, and a few pages are devoted to those of America. The rise of the historical school in the chief countries of Europe and in America is then traced. In conclusion, the author says that political economy has been heretofore governed to its detriment by the methods of metaphysics, and that its progress depends on the substitution of scientific methods; that it must be studied in its relations with the science of sociology which includes it; and that the doctrine of right which lay at the basis of the system of "natural liberty" must be replaced by a new doctrine of duty regulating the co-operation of each class and member of the community.

THREE CRUISES OF THE UNITED STATES COAST AND GEODETIC SURVEY STEAMER BLAKE, in the Gulf of Mexico, in the Caribbean Sea, and along the Atlantic Coast of the United States, from 1877 to 1880. By ALEXANDER AGASSIZ. Boston and New York: Houghton, Mifflin & Co. Two vols. Pp. 314 and 220. Price, $8.

THE author styles this work "a contribution to American Thalassography," meaning by that word the science which treats of oceanic basins. While we have had narratives of explorations with general summaries of results and special treatises and papers on particular points, which may altogether cover the whole subject, there has previously been no American work treating it comprehensively and systematically; although the fruits of English research have been embodied in the masterly books of Wyville Thomson and Wild. The expeditions of the Blake were by no means of minor importance among the enterprises for investigation of the deep seas. They covered a less extent of territory than the Challenger Expedition, but the region in which they operated is among the most interesting divisions of the ocean in the lessons which it affords concerning the relations of currents and temperature with the development and distribution of organic life; and its well-defined limitation made a thorough and nearly exhaustive survey all the more feasible. That the survey has been fruitful in results, in both the physical and biological departments, is attested by this careful and well-arranged presentation of the facts which were learned from it. Condensing the narrative into a very few pages, the author goes at once to the consideration of the immense variety of

facts which the expeditions have added to knowledge, separating them according to their classes, and relating those of each class topically. Mr. Agassiz may call himself a veteran in thalassographic work, for his connection with it began in 1849, when, as a boy, he accompanied Prof. Agassiz in his cruise of the Bibb off Nantucket. He afterward, in 1851, served as the professor's aid in his survey of the Florida Reef. Afterward he reported upon a part of the collections made by Pourtales in the Bibb in deep water in 1867–'68. Since then he been almost continuously engaged on deep-sea work. In the brief chapter in which is embodied the narrative of the expeditions are given some observations, with pertinent illustrations, on the physiognomy and structure of the smaller West India Islands. In the first volume, after a full account of the equipment of the Blake for its work, including Sigsbee's improvement in sounding-apparatus, and a "Historical Sketch of Deep-Sea Work," the characteristic features are general discussions of the fundamental facts and principles ascertained in the research. The chapter on "The Florida Reefs" embodies a study of the manner in which the peninsula of Florida and its hemming reefs originated and have come to their present condition—in which Darwin's theory of coral reefs is found not to apply. Next is considered the "Topography of the Eastern Coast of the North American Continent," of which only the most general features were known before the explorations of the Blake. The further presentation of the general principles comprises the discussion of such topics as the "Relations of the American and West Indian Fauna and Flora"; "The Permanence of Continents and of Oceanic Basins"; "Deep-Sea Formations"; "The Deep-Sea Fauna"; "The Pelagic Fauna and Flora"; "Temperatures of the Caribbean, Gulf of Mexico, and Western Atlantic"; "The Gulf Stream"; "Submarine Deposits"; and the "Physiology of Deep-Sea Life." All these papers are of great physiographical importance, and present at considerable length and in detail the results obtained by the Blake expeditions, supplemented by those derrived from the Challenger and other investigations. The second volume is occupied with fuller and specific descriptions of the various forms of deep-sea life obtained by the surveys and dredgings, beginning with a summary review of the "West Indian Fauna," and continued with chapters, illustrated by original figures, either prepared for this work or borrowed from the office of the Coast Survey, on "The Fishes," "Crustacea," "Worms," "Mollusks," "Echinoderms," "Acalephs," "Polyps," "Rhizopods," and "Sponges." The essentials to every good book, a list of figures and an index, are not forgotten, but are given in a full and satsfactory style.

AMERICAN FISHES. By G. BROWN GOODE. Illustrated. New York: Standard Book Co. Pp. 496. Price, $5.

THE rule which has guided Prof. Goode in selecting, from the 1,750 species indigenous to our waters, the fishes to be described in this book, is to include "every North American fish which is likely to be of interest to the general reader, either because of its gameness or its economic uses." The author gives the physical features of each fish, tells its range and season, its habits in regard to feeding, migration, and breeding, with something about methods of capture, and value as food. Mingled with these facts is much curious information about the different names of fish in different places, many exciting fishing adventures, and appropriate quotations in prose and verse from Izaak Walton and other writers, both old and recent. "This volume has been prepared," says Prof. Goode, in his prologue, "for the use of the angler, the lover of nature, and the general reader. It is not intended for naturalists, and the technicalities of zoölogical description have therefore been avoided. . . . A figure of almost every species discussed is presented, by the aid of which any one interested in fishes can determine the correct zoölogical name of the form before him." To prevent a possible mistake as to the scope of the work it may be well to repeat the author's caution that it contains "no discussions of rods, reels, lines, hooks, and flies, and no instructions concerning camping out, excursions, routes, guides, and hotels." The field occupied, however, is wide enough to make the book interesting to a large circle of readers, and its reliability may be inferred from the author's intimate

acquaintance with the subject, which made him the first choice as successor to Prof. Baird in the office of Commissioner of Fish and Fisheries. His own work, too, has been supplemented by that of the late Commissioner, and of Dr. Jordan, Dr. Bean, Capt. Collins, Mr. Earll, and Mr. Stearns. The classification followed is the system elaborated and advocated by Dr. Gill.

THE STORY OF CREATION: A PLAIN ACCOUNT OF EVOLUTION. By EDWARD CLODD. Illustrated. London and New York: Longmans, Green & Co. Pp. 242. Price, $1.75.

THE purpose of this book is to give a view of the doctrine of evolution throughout the realm of Nature, and of the kind of evidence which supports it. The book is divided into two parts—descriptive and explanatory. In the former, the relations of matter and power in the universe, and the chief features of the solar system are touched upon, while the past life-history of the earth and an account of the present life-forms are given more at length. In the explanatory part, much the same order is followed. Beginning with the universe, the accepted theory of its becoming and growth is stated; then follows a discussion of the origin of life, after which the question of the origin of species is taken up, and the proofs of the derivation of species are given. Finally, the author enters the field of social evolution, and shows the application of the doctrine to psychology, society, language, art, science, morals, and theology. He insists on a distinction between morals and theology, but does not join issue in the vexed question of the relations of science and religion. The style of the text is popular and picturesque, and the volume is abundantly illustrated.

THE GEOLOGICAL EVIDENCES OF EVOLUTION. By Prof. ANGELO HEILPRIN. Illustrated. Philadelphia: The Author. Pp. 99.

IN this brief sketch, which is extended from a discourse delivered at the Academy of Natural Sciences of Philadelphia, Prof. Heilprin presents a popular view of some of the evidences in support of organic transmutation afforded by geology and paleontology. He shows first that in geologic time "there has been a steady advance in the type of structural organization from first to last—not a necessary elimination of forms of low degree, but an overbalancing of these by forms of a more complicated or higher grade of structure." He then traces back the history of several groups of animals, showing that by gradual modification they are derived from ancestral forms which are connected also with other and very dissimilar modern groups. In the greater part of this discussion, data drawn from the vertebrate animals are used, but the author adds, in closing, a few cases drawn from the mollusks, which present equally striking proofs of modification. The book is exceedingly well adapted to promote a general intelligent belief in the doctrine of evolution.

IN NESTING TIME. By OLIVE THORNE MILLER. Boston: Houghton, Mifflin & Co. Pp. 275. Price, $1.25.

THIS volume belongs to a class which is happily becoming more common than formerly, namely, accounts of observations of nature. The habits and actions of birds, both free and in confinement, form the subject of the book, and the modest introductory note claims for the sketches only that they are genuine studies from life, not that the facts are all new to science. The glimpses at bird-life which the author gives have a freshness and sprightliness that make them intensely fascinating reading, while they have also an instructive value due to their revelations of bird habits and character.

A TREATISE on *The Fundamental Principles of Chemistry* has been written by Prof. *Robert Galloway*, of London (Longmans), which differs widely from the common text-books on chemistry. The author holds that the ordinary chemical works intended for beginners follow too much the cyclopædic plan of great reference books, and he quotes Prof. J. P. Cooke as saying of such works: "To the great mass of learners the study of these text-books is uninteresting and profitless, for before the student is made familiar through long laboratory practice with the materials and processes described, such a book is little more to him than a catalogue of names, to which he attaches no significance." The present volume is more like Prof. Cooke's "New Chemistry" than any

other chemistry with which American teachers are acquainted. It is a presentation of principles without much descriptive matter. The first part of the book is devoted to physical properties and forces, merging into chemical physics, which prepares the way for the course on pure chemistry that follows. "In the teaching of this portion of the work," says the author, "the exercises, illustrations, etc., have been selected to bear on the after-course and on chemical operations generally. Thus, in explaining porosity, filtration is illustrated and taught practically; the collecting and storing of gases, under impenetrability; the determination of boiling-points, fractional distillation, etc., under heat; the action of charcoal and dyeing, under adhesion, etc.; so that when the purely chemical portion of the work is reached the student will not be perplexed and impeded when reference has to be made to physical properties and physical forces. The principles are taught by experimental and arithmetical exercises and examination questions. Answers to many of the exercises are given at the end of the work." The book is suitable for students in colleges and high-schools. It is strange to see a work of this character without an index.

The Lackawanna Institute of History and Science has issued a first volume of its *Proceedings and Collections.* This society was organized in the winter of 1885–'86 at Scranton, Pa., for the promotion and diffusion of historic and scientific knowledge, especially that relating to the vicinity. The locality affords an exceptional amount of material for scientific study, for in addition to its fauna, flora, and minerals, it has the coal-measures with their wealth of fossils, and it lies within the area traversed by the ice of the glacial epoch. The present volume contains a lecture on "Glaciation: its Relations to the Lackawanna-Wyoming Region," delivered before the institute by John C. Brauner, Professor of Geology in the University of Indiana, and "A Preliminary List of the Vascular Plants of the Lackawanna and Wyoming Valleys," compiled by William R. Dudley, of Cornell University. Following these are the proceedings and by-laws of the society.

Lessons in Geometry is a small text-book by *G. A. Hill* (Ginn, 70 cents), prepared for those who desire a short and easy introductory course in geometry, adapted to pupils between the ages of twelve and sixteen. In these lessons large use is made of exercises in drawing to scale. The training in consecutive reasoning is introduced very gradually, and is confined mainly to the laws of equal triangles and a few of their simple applications. As here presented, geometry is intended to be studied before algebra. The contents of the book may form a course for two years or may be abridged so as to be covered in one year.

The first number of *Science and Photography* (Jas. W. Queen & Co., Philadelphia, $1 a year) has come to hand. It comprises articles bearing on various points in the practice of photography and a few papers on other scientific matters.

The *Annual Report of the State Geologist* of New Jersey for 1887 (*G. H. Cook*, State Geologist, New Brunswick) is only a business statement of the affairs of the survey, the near completion of the work making it unadvisable to go into detail as fully as has been the case in former annual reports. The first part of the final report may be expected in a short time. It will be upon the physical geography of New Jersey, and will embody in its texts the results of the geodetic, topographic, and magnetic surveys. The main work of the year was given to the completion of the topographical survey and maps of the State. Some field work was done in the exploration and study of the archæan rocks in Sussex County, examinations were made of the glacial and terrace deposits of the Delaware above the Water Gap, a careful and detailed survey was made of the zinc-mines of Franklin Furnace for the purpose of making a model of the vein, and attention was given to the questions of water-supply and drainage. A fine topographical map of the State by C. C. Vermeule accompanies the present volume. The survey and its documents are attracting increasing attention from citizens of the State.

The Fifteenth Annual Report on the Geological and Natural History Survey of Minnesota, by Prof. *N. H. Winchell* (Minneapolis, Minn.), has been issued. It covers the year 1886 and comprises a report by Prof. A. Winchell on the work of the party under his charge, a report by Prof. N. H. Winchell

largely taken up with the geology of the iron-bearing rocks of northern Minnesota, and several brief papers. The volume is illustrated with geological maps and many structural figures.

Dr. *M. E. Wadsworth* was in charge of a surveying party during a part of the summer of 1886, but devoted the rest of the season to laboratory work, the result of which is published as Bulletin No. 2 of the Minnesota survey, entitled *Preliminary Description of the Peridotytes, Gabbros, Diabases, and Andesytes of Minnesota.* The paper comprises general descriptions of the Minnesota rocks belonging to these groups, with a great many special descriptions of specimens collected in the northern part of the State.

Bulletin No. 4 of the survey is a *Synopsis of the Aphididæ of Minnesota*, prepared by *O. W. Oestlund.* A general description of the *Aphididæ* and a bibliography of the family are prefixed to the synopsis, and a list of North American plants with the names of species known to attack them is appended. The species of plant-lice treated in this paper were mostly collected along the Mississippi River; but the author has also added notes from other localities, so that he considers the report as applying to the whole State, except the pine district in the northern part.

A quarterly journal called *The Climatologist* began life with the number for January (P. O. Box 274, Washington; 50 cents a year). Its chief object will be to present information as to the climatic conditions of various regions and resorts with especial regard to their influence on the preservation of health and the cure of disease. Various sanitary subjects will also come within its scope.

The instructors, pupils, and friends of *Adam Todd Bruce*, Ph. D., have issued a quarto memorial volume containing his thesis entitled *Observations on the Embryology of Insects and Arachnids*, written for his examination for the degree of Ph. D. Prefixed to the thesis is a sketch of the scientific work of Dr. Bruce by Prof. W. K. Brooks. This young biologist graduated from the University of New Jersey in 1881. He obtained the degree of Ph. D. at the Johns Hopkins University in June, 1886, and was appointed an instructor there in September following. He died in March, 1887. The volume contains six plates illustrating the thesis and a portrait of the author.

Inebriety: its Etiology, Pathology, Treatment, and Jurisprudence, by *Norman Kerr*, a physician, whose titles and offices indicate that he is an expert in the study of the subject (Philadelphia, P. Blakiston, Son & Co.), has been prepared in response to numerous inquiries which have been addressed to the author regarding the best course to be adopted in dealing with the inebriate. The one common feature of most of these inquiries "has been the non-recognition of a disease element in inebriety, and the acknowledgment of only a moral depravity." Dr. Kerr takes an opposite view, and holds, with Dr. Crothers, of Hartford, that inebriety is a disease, in the face of which the victim is helpless, and that it can be cured only by suitable medical treatment and regimen. In elaboration of this view, he has prepared the present full, methodical treatise on the subject in all its aspects, illustrated with copious citations from his own and other professional experience and observation. The disease inebriety having been described as allied to insanity, five chapters are given to the consideration of its various forms; four to its etiology, with special studies of its predisposing and its exciting causes; two to its pathology; five to its treatment, which, as the disease is a complex one, is necessarily intricate, and is most successful in special homes where the surronndings can all be made favorable; and five to its medico-legal aspects. Under the last heading it is very evident that the legal treatment upon the theory that inebriety is a disease must be quite different from the present system, which regards it as a vice.

The Journal of Physiology (Cambridge Scientific Instrument Co., England) presents in No. 1 of Vol. IX three papers, with notes of proceedings. The first paper, by C. A. MacMunn, is "On the Chromatology of some British Sponges," and consists of examinations of the coloring matters in twelve species of sponge from Tenby. In ten of them he found chlorophyll, differing in no respect worth mentioning from vegetable chlorophyll; he also found lipochromes in nearly all, and a histohæmatin in seven. As to what use chlorophyll is to sponges, Dr. MacMunn suggests that it may sift out light-

rays of a certain wave-length to be utilized in the synthesis of the carbohydrates, etc. The second paper is by G. N. Stewart, and deals with "The Effect of Stimulation on the Polarization of Nerve," and the third is by W. Griffiths, "On the Rhythm of Muscular Response to Volitional Impulses in Man." The third paper presents comparisons of myograms taken from voluntarily contracting muscles, and the conclusions obtained with different muscles, different persons, different weights, different times of contraction, etc.

The second number of the *Journal of Morphology* (Ginn) contains five papers, viz.: "Oökinesis," by C. O. Whitman; "The Embryology of Petromyzon," by Dr. W. B. Scott; "A Contribution to the Embryology of the Lizard," by Dr. Henry Orr; "The Fœtal Membranes of the Marsupials," by Dr. H. F. Osborn; and "Some Observations on the Mental Powers of Spiders," by George W. and Elizabeth G. Peckham. The papers are illustrated with ten plates and several diagrams.

The first part of *Professor W. Preyer's* observations upon the development of *The Mind of the Child*, which relates to the senses and the will, has been translated for D. Appleton & Co.'s *International Education Series*, by *H. W. Brown*, of the State Normal School, at Worcester, Mass., an institution in which the students are taught themselves systematically to make and record observations upon the children whom they meet or come in contact with. The importance of the subject to teachers hardly needs enlarging upon; for it is obviously one of the most essential qualifications they should possess for their work that they should be acquainted with the nature of the object which they are to operate upon, whose continued development they are to aid. Of all the series of observations that have been recorded on the mind of the child, those of Professor Preyer have been probably the most thorough and systematic, and are described in the most lucid manner. He kept a complete diary of all childish acts and the acquisition of new powers from the birth of his son to the end of his third year; occupied himself with him at least three times a day, guarding him, as far as possible, against such training as children usually receive, and found nearly every day some fact of mental genesis to record. The substance of that diary has passed into this book. The record is enriched by notes of observations on other children and contributions from other persons. The whole forms a valuable foundation on which teachers may base their own individual studies, and a guide for the right conducting of them.

A paper on *European Schools of History and Politics*, read by Mr. *Andrew D. White* at the Johns Hopkins University in 1879, has been revised, and is published in the "Studies," edited by Prof. H. B. Adams. Although the editor puts only Mr. White's name on the title-page of the pamphlet, and runs the title of his paper as a heading over all the pages, scarcely half of the pamphlet is occupied by Mr. White's paper. The other contributions are "Modern History at Oxford," by W. J. Ashley; "Recent Impressions of the École Libre," by T. K. Worthington; and "Preparation for the Civil Service in German States," by L. Katzenstein, with a "List of Books upon the German Civil Service." Mr. White gives an account of the recent growth of the department of history and politics at some of the centers of European instruction, and then applies this European experience in discussing the need in our own country for men trained in these subjects.

In *Mary F. Hyde's Practical Lessons in the Use of English*, book two (D. C. Heath & Co.), the sound plan adopted in the former volume, of bringing only correct forms to the attention of the pupil, is adhered to. The exercises are a step more advanced in character than those of the former book, and are illustrated by selections from the works of Longfellow, Whittier, and Lucy Larcom. The aim observed throughout the work has been to lead the pupil to see for himself, to cultivate the powers of observation at every step; and, instead of discussing why certain forms are right and others wrong, to train him habitually to use the right expression.

D. C. Heath & Co. have added a second part of *Mrs. Julia McNair Wright's Seaside and Wayside* to the series of Nature Readers. It is substantially a continuation of the plan developed in the first part, and describes a

walk with the child-pupil by the sea-shore and along the road, with easy conversations concerning the nature, habits, life-history, etc., of the living creatures which the pair meet. These living creatures in the present volume are ants, earthworms, flies, beetles, barnacles, jelly-fish, starfish, and dragon-flies. The purpose is to lead the child by pleasant steps to the study of nature, and interest him in it. The talks are fitly illustrated.

The Report of the New York State Superintendent of Public Instruction for the year ending August, 1887, has been issued. The view of the condition of public education in the State, given by the Hon. A. S. Draper, the superintendent, is not characterized by that unalloyed complacency which pervades the generality of educational reports, but is a vigorous statement of what the schools of the State need for their further advancement. Among the special work of the year which he reports are the preparation of a new "Code of Public Instruction," the obtaining of a series of designs for school-houses, and an investigation in regard to compulsory education in other States and countries, made by Sherman Williams. The report on this investigation is printed with the superintendent's report. The usual statistics are given in the exhibits appended to the report.

The second "Monograph" of the Industrial Education Association (New York) is a brief paper on *Education in Bavaria*, by Sir *Philip Magnus*. It describes each kind of school maintained in that kingdom, and gives other general information on the organization of the Bavarian educational system.

No. 2 of *The American Journal of Psychology*, edited by Prof. *G. Stanley Hall* (N. Murray, $3 a year) contains an article on "The Relation of Neurology to Psychology," by Henry H. Donaldson, Ph. D., in which he summarizes certain recent advances in neurology, with a view to indicating what the field is and what some of the results are. There is also an article on "Insistent and Fixed Ideas," by Edward Cowles, M. D., which is illustrated by a detailed history of a complicated case of mental derangement. A paper by Joseph Jastrow, Ph. D., entitled "A Critique of Psycho-Physic Methods" deals with the methods and interpretation of such psycho-physic experiments as can be utilized for establishing Weber's law.

The Heart of the Creeds, or *Historical Religion in the Light of Modern Thought*, by *Arthur Wentworth Eaton* (G. P. Putnam's Sons), is an attempt to make clear the universal meaning in the rites and symbols of Christian faith, and to aid the believer in discriminating between what is necessary and what is accidental in religion. It is written from the orthodox point of view, and predominantly from that of the Protestant Episcopal Church. In this sense are considered the topics of "God," "Man," "Christ," "The Creeds," "The Bible," "The Church," "The Sacraments," "The Liturgy," and "The Future Life," each article being preceded, as in a sense of foretaste of what is to come, by a selection of terse expressions of thought on the subject by representative Christian writers of all ages.

G. P. Putnam's Sons have added to their series of "English History by Contemporary Writers," of which we have already noticed the first two volumes, *Simon of Montfort and his Cause*, by the *Rev. J. Hutton*, and *Strongbow's Conquest of Ireland*, by *Francis Pierrepont Barnard*. The former volume is made up chiefly of selections from the writings of Robert of Gloucester, Matthew Paris, and other contemporary chroniclers, and the latter from the works of Gerald of Barri and several other documents, including the Anglo-Norman poem on the conquest known as "Regan." This series is under the general editorial direction of Mr. F. York Powell, and aims at so setting forth the facts of English national history from contemporary documents, letters, and papers of all sorts, as to send the reader to the best original authorities, and at the same time to give a living picture of the effect produced upon each generation by the political, religious, social, and intellectual movements in which it took part, and thus to bring him as close as may be to the mind and feelings of the times he is reading about.

A work on finance, by *Dr. Luigi Cossa*, has been translated, and appears under the title *Taxation: its Principles and Methods* (Putnam, $1), with an introduction and notes by Horace White. It is essentially a volume of definitions and classifications, enumerating

in short paragraphs the kinds of public expenditure, the sources of public income, the forms of property on which taxes are laid, the varieties of public debt, and the ways of managing it. There is little discussion of policies in the body of the book, though the chief reasons for and against certain financial methods are briefly stated. Mr. White has, however, inserted discussions on taxation of mortgages, of personal property, of corporations, of land values, and taxation on consumption. Prof. Cossa's bibliography of the science of the finances is reproduced with additions, and compilations of the tax systems of New York and Pennsylvania are appended.

The Modern Distributive Process, by *John B. Clark* and *Franklin H. Giddings*, is composed of four articles, two by each author, contributed to the "Political Science Quarterly." The titles of the papers are "The Limits of Competition," "The Persistence of Competition," Profits under Modern Conditions," and "The Natural Rate of Wages." They are studies of the new conditions of the distribution of wealth resulting from the interference with competition caused by pools, trusts, labor unions, etc., and aim to show how much of the Ricardian theory of distribution persists in this new stage of economic evolution.

A fourth edition (revised) of *Constitutional History and Political Development of the United States*, by *Simon Sterne* (Putnam, $1.25), has just appeared. It is a popular work, consisting of "a sketch of the Constitution of the United States as it stands in text, and as it is interpreted by the Supreme Court, accompanied by a history of the political controversies which resulted in the formation of and changes in that instrument, together with the presentation of the actual situation of political parties and questions, which, in their turn, may produce constitutional changes." In the new edition, part of the book has been rewritten, and addenda have been supplied bringing the constitutional history and political changes of the nation from 1882 down to the end of 1887.

There are many persons who will be enabled to transact their business more securely by means of *Hints from a Lawyer*, a little manual by *Edgar A. Spencer* (Putnam, $1.25). Its object is to present the laws and methods relating to the care of property, the investment of money, the distribution of estates, and to marriage and divorce. It aims also to instruct the reader as to when the lawyer's counsel should be sought, and how such counsel can be best utilized. A large part of the text is in the form of questions such as a client would ask a lawyer, with the appropriate answers. It is adapted to all the States.

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Bell, W. S. The French Revolution. New York: Truth-Seeker Company. Pp. 81. 25 cents.

Büchner. Dr. Louis. Materialism. New York: Truth-Seeker Company. Pp. 28.

Clark, Dr. Daniel. The Public and the Doctor in Relation to the Dipsomaniac. Toronto, Canada. Pp. 20.

Cooper Union. Twenty-ninth Annual Report of the Trustees. Pp. 64.

Cornell University. Bulletin of the Agricultural Experiment Station. Pp. 8.

Davis, J. R. A. A Text-Book of Biology. Philadelphia: P. Blakiston, Son & Co. Pp. 462. $4.

Denslow, Van Buren. Principles of the Economic Philosophy of Society, Government, and Industry. Cassell & Co. Pp. 782. $3.50.

Eagle Sanitary and Cremation Co. George H. Warner, P. O. Box 1040, New York.

Fellows, G. S. "Loisette" Exposed. New York: G. S. Fellows & Co. Pp. 224. 25 cents.

Foster, Rev. John O. Life Sketches and Speeches of Gen. Clinton B. Fisk. Chicago: Woman's Temperance Publication Association. Pp. 108, with portrait. 25 cents.

Giddings, Franklin H., Springfield, Mass. The Sociological Character of Political Economy. Pp. 19.

Gilbert, C. K. Changes of Level of the Great Lakes. Pp. 12.

Gould, S. C., Manchester, N. H. Bibliography of the Polemic Problem, What is the Value of π? Pp. 32.

Grabfield, J. P., and Burns, P. S. Chemical Problems. Boston: D. C. Heath & Co. Pp. 87.

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Morris, Charles. The Aryan Race. Chicago: S. C. Griggs & Co. Pp. 347. $1.50.

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Pickering, Edward C. Second Annual Report on Photographic Study of Stellar Spectra. Pp. 8, with 2 Plates.

Quick, M. W., Titusville, Pa. Modern Speculation. Pp. 34.

Ripley, Chauncey, University of New York, Law Department. Address on Presentation of Memorial Portrait of John N. Pomeroy, etc. Pp. 25.

Starr, Dr. Elmer, Buffalo, N. Y. Photographing the Interior of the Living Human Eye. Pp. 5.

Stockham, G. H., M. D., Oakland, Cal. Temperance and Prohibition. Pp. 131. $1.

Todd, J. E. Directive Coloration in Animals. Pp. 7.

University of Illinois. Agricultural Experimental Station. Bulletin No. 1. May, 1888. Pp. 13.

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Wolff, Alfred R. Efficiency of Mechanical Engineering Schools. Pp. 7.

Wright. G. Frederick. The Age of the Ohio Gravel-Beds. Pp. 9.

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POPULAR MISCELLANY.

The Dynagraph.—From a description of this instrument, which its inventor, Mr. P. H. Dudley, read before the New York Academy of Sciences, we select a few notes. The first dynagraph was made in 1874, and used paper eleven inches wide for its records. A later instrument uses paper of twenty or thirty inches width as desired. The recording apparatus occupies a floor space of about thirty-four by forty inches, in a car specially constructed for its use, and is thirty-seven inches high. It is placed over a special six-wheel truck, which carries many distinct sets of apparatus to furnish required indications, the results being electrically recorded by the battery of electro-magnetic pens on the recording apparatus. As the car moves, the paper is fed through the instrument, the rate when inspecting track being one inch of paper for each fifty feet of track. The apparatus may, if desired, take the dynamometrical curve, and inspect the track at the same time. From this curve, the number of foot-pounds of work expended in moving the train any selected distance is calculated. All movements of the cut-off, up or down, or of the throttle-valve, in or out, are shown by the curve. Aside from all other conditions, each engineer, especially on a freight-train, gives the curve a personal equation, a good one, if he is a first-class runner, thoroughly acquainted with the line, so he is able to work his locomotive to the best advantage, saving in fuel and time. Such engineers can draw more cars, with a given locomotive, than those who are not so well versed. One practical result of the use of the dynagraph was the discovery which has been verified in practice, that for freight-trains, on the Lake Shore and Michigan Southern Railroad, the locomotive gave a much more economical development of power running eighteen to twenty miles an hour, than when running ten to twelve miles. Further, the saving in running time of a train from Chicago to Buffalo was twenty-four hours, giving the road a much greater capacity with the same equipment. The track inspection includes the measurement of surface undulations and side deflections in the rails, the measurement of gradients, and of the curvature and alignment of the line. Lines are also traced showing the distance passed over, the time in seconds, side oscillations of car, the consumption of each cubic foot of water, and each twenty-five or fifty pounds of fuel, the velocity of wind, revolutions of drivers, intervals of firing, and duration of black smoke. Any special piece of electrical recording apparatus can be put in circuit with a pen, and its indications recorded. From the character of the delineations it is at once seen whether the rails are rough and bent, joints low, worn out, or loose on the ties, and whether any permanent improvement which can be made

by labor or new material is required. As the car runs over the track "low-point markers" eject paint under the heads of the rails where deflections occur, thus showing to trackmen where their labor is needed. Diagrams of track inspection have demonstrated that with sixty-five or sixty-seven pound rails the deflections were more than was generally supposed, and have led to the introduction of seventy-two and eighty pound rails.

Systematic Reading for Teachers.—Dr. Jerome Allen, of New York, gave, at the meeting of school superintendents held in Washington last year, a summary of the principles on which the teacher's systematic reading should be conducted. In the matter of primary knowledge as a teacher, he ought to read that which will most directly help him in the work of instruction. His pupils are human beings; he must know what they are, morally, mentally, and physically. He is especially set to train the mind; it follows, then, that he must study mind-growth and mind-science. How to train the mind into a symmetrical maturity is the most important knowledge a teacher can gain. All text-book knowledge is secondary in comparison with this. If a teacher knows all science, literature, and art, and does not know the mind and its growth, he is not prepared to teach. His work is empirical. The reading for secondary knowledge comprises methods of instruction, organization, school government, school systems, school laws, and the history of education.

The Three Grades of Hand-Work.—In a paper on "Sense and Hand-Training in Public Schools," Prof. Joseph Le Conte affirms that as drawing, if introduced, should be not for making artists, but for training the brain through eye and hand, so hand-work should be not for making carpenters or blacksmiths, but to train the brain by co-operation of hand and eye. If in biology the training is mainly of the brain through the senses, in hand-work the training is mainly of the brain through the hand. If one is mainly observing and thinking, the other is mainly thinking and doing. It is impossible to doubt the importance of hand-training from this point of view. All admit the absolute necessity of the use of the hand in the brain-culture of the child. All now admit also that the best scientific culture in the university requires the use of instruments of research—the microscope, telescope, the balance, the measures of force of many kinds. But in the whole wide space between, viz., in the school and the college, this great agent of culture is wholly left out. Now, I am quite sure that for every grade of culture, whether of the individual or of the race, there is a corresponding grade of hand-work necessary for the best brain-culture. In the child of pre-school age and in the savage and in palæolithic man, it is the simple use of the hand, or assisted by rude implements. In the school boy or girl, as also in the next higher grade of races, it is by the use of those finer instruments which we call tools. In the university, as in the most civilized races, it is by the use of scientific instruments and machines. The three grades of hand-work, then, are the use of implements, tools, and instruments. That especially adapted to the schools is the use of tools. But not only is hand-training in the schools an immediate and very urgent want, but by the necessary differentiation of human pursuits and the increasing divergence of school from actual life, is becoming more so every year.

Perforated Stones from California.—These objects are found abundantly in Southern California, varying in weight from an ounce, or even less, to several pounds. In shape they are most frequently circular, or nearly so, but occasionally they are irregularly oblong, and some are more or less globular, while others tend to the pear-shape. Mr. H. W. Henshaw states that by the surviving Indians of Santa Barbara and Ventura Counties the stones were formerly put to three uses: first, as weights to digging-sticks; second, as gaming implements; and third, as dies for fashioning tubes, pipes, and similar cylindrical objects. A Santa Barbara Indian, to whom a specimen was shown, a man sixty or more years of age, unhesitatingly affirmed, the moment he saw it, that it was a digging-stick weight. This implement, he said, was formerly in use among the women in his tribe. The stick must be strong and very hard; the wood usually employed grew only in the mountains. The especial function of the digging-stick was to dig a kind of onion-

like root. When in use, the weight was slipped over the handle till it rested at about the middle of the stick, like a collar. An old woman living in a village of the San Buenaventura Indians, thirty miles distant, corroborated the above statement as to the use of the stones. When one was put into her hands it at once excited her surprise and interest. In reply to the question, "What do you know of its use?" she instantly seized a small stick from the fireplace and slipped the ring down to its middle, holding it there with the left hand, and began to dig industriously into the dirt floor. From an intelligent half-breed of the same village, Mr. Henshaw learned that many of the stone disks were used in a game which was played as follows: A piece of level ground was selected for a court, and was made very smooth and hard. At one corner of the court was stationed a man whose business it was to cast the disks. The player, with a lance six or seven feet long in his hand, stood on one side of the court. Running a little distance, the bowler rolled a disk swiftly across the court, when the lance-thrower darted forward and cast his lance, the object being to transfix the disk as it rolled past. A successful throw counted one point, ten being the game. Dr. W. J. Hoffman was informed that at Santa Barbara the bow and arrow were in use in this game in place of the lance. The San Buenaventura half-breed stated that some of the perforated disks of hard stone were made for the express purpose of fashioning pipes. The end of the stone to be fashioned was inserted into the hole of a perforated stone and turned by the hand till reduced to the proper shape. The perforated stone hence served as a kind of die. Mr. Henshaw has found no evidence to show that these stones were used as net-sinkers, spindle-whorls, or club-heads.

A Fatal "One Glass." — A new book, called "Manners Makyth Man," gives a story told by a bishop of how he persuaded a man recovering from delirium tremens to become a teetotaler. "Years went by, and not a drop of intoxicating liquor entered his mouth. Six, seven, eight years passed, and his resolution remained unbroken. On the anniversary of the eighth sober year his friends, thinking the reformation complete, resolved to give a dinner in his honor. A family circle, rendered happy by the temperance of its head, received the congratulations of intimate friends. But it was a feast of deadly wine. Healths were proposed, and he who was being honored was told that to drink his own health in one glass could certainly do him no harm after totally abstaining for eight years. He drank the glass, and two years afterward I was called in to visit a poor drunkard who was on his death-bed by reason of that one 'friendly glass.'"

Technical Education. — In a paper on "Technical Education," G. S. Ramsay maintains that British workmen are not deficient in technical skill in any mechanical department, but, as a rule, distance those of most other nations. British work is inferior to foreign in two classes of departments: in those connected with processes requiring a scientific knowledge of chemistry of the highest kind, and in those in which success depends essentially upon taste, and upon the faculty of design. An instance under the former category is given in the manufacture of coal-tar dyes, which has been carried off from "under the very noses" of the British by the superior scientific skill and industrial capacity of another nation. British manufacturers furnish the material; Germans, under the direction of trained chemists, work it up, and sell back to the British the products in the form of beautiful colors and concentrated essences. Thus a works near Basle employs a chemist of comprehensive training and experience, three departmental chemists, and several assistants. Another one, near Frankfort, employs fifty-one scientific chemists. The manufacture of beet-sugar has been developed in Germany into a great trade by being treated as a scientific business, "to be carried on in strict obedience to the commands of scientific experts." In these operations the technical part of the work is made subordinate to the scientific principles on which it is based. British butter and cheese are being superseded in the markets by American and Canadian products, through the neglect of scientific improvements at home and the introduction of them in the competing countries. "In each of these cases," says Mr. Ramsay,

"we find the same state of things. The British producer fails to understand the importance of pure knowledge; he despises and disbelieves a knowledge of principles, and imagines that the only thing he need know is the application of those principles to his own particular work. In his eyes practice is everything, knowledge for its own sake, knowledge of principle, is nothing; as if there could be any value at all in practices unless he knows the reasons on which they rest. Our producers are like students who cram for an examination by getting up 'tips,' instead of getting up sound knowledge of the subject. The present cry for technical education is itself, to a large extent, only a new example, in an exaggerated form, of the same vicious idea. So far as it leads people to suppose that success in production or in life is to be gained from a knowledge of *technique* — of methods, of processes, of manipulation—instead of impressing upon them that all these are wholly unimportant and useless in comparision with a real education in the subject concerned, and a knowledge of the principles on which the *technique* is founded, its effect will be wholly bad. The idea that there are short practical cuts to just so much knowledge, and no more, as we need for the particular job in hand, is one which, if adopted, would demoralize our education to its root, as in diametrical opposition to the whole tenor of the evidence which has been collected in Germany and other countries."

A Jadeite Adze from Mexico.—Mr. George F. Kunz exhibited at the American Association a jadeite adze found at Oaxaca, Mexico, about twenty years ago, which was remarkable for its extraordinary size, and for the peculiar character and excellence of the working exhibited in so hard a material. It is $10\frac{13}{16}$ inches long, 6 inches wide, $4\frac{5}{8}$ inches thick, weighs 229·3 oz. troy, and is light grayish green, with streams of an almost emerald green on the back. In style of ornamentation it closely resembled a gigantic adze of granite which is mentioned by A. Chavero in his "Mexico al Través de los Siglos," and it has almost an exact counterpart in the aventurine quartz adze now forming a part of the Christy collection at the British Museum. It, however, differs from these objects in having no ornamentation on the forehead, and in having in addition three dull markings on each ear, one under each eye, and one near each hand, which could serve no other purpose than to hold thin flakes or films of gold, of which, however, no trace can now be seen. The adze is, from all appearance, the result of the shaping of a bowlder, for it presents evidences of weathered surfaces. The lapidary's work on this piece is perhaps equal to any that has ever been found, and the polish has not been surpassed. It is an interesting fact that, notwithstanding this adze is one of the finest objects which its Mexican owners possessed, they desired to "extend" the material; and for that purpose made three attempts to remove pieces from the object. Enough has been cut from the back of the adze to equal, perhaps, one eighth of the entire weight. The appearance of the cuts gives support to the supposition that the cutting was done with a string and some abrasive. The author had previously described in the "American Journal of Science" for July, 1882, a sapphire pebble found in a brook at Oaxaca. If the people were acquainted with this mineral, we can more readily understand how they were able to work so hard a substance as jadeite. So far as the author was able to understand, no similar object of such magnitude and equal archæological interest exists. The Humboldt celt, the Leyden plate, the Vienna adze, and the adze in the Ethnological Museum at Dresden, can hardly compare with it.

The Name of America.—Evidence is accumulating that the name of America is indigenous to our continent, and not borrowed from the name of an early navigator, as the world till now has supposed. M. Jules Marcou has found it in the name of a range of mountains in Central America—the Amerique range—and also in that of a tribe of Indians living upon it—the Ameriques. A more careful and thorough study of the subject has been made by Mr. "Thomas de St. Bris," whose pamphlet, *Discovery of the Origin of the Name of America*, can be obtained by addressing *P. O. Box No. 1852*, New York city, or from the American News Company. It appears from his investigations — the sources of which he names and are nearly

all to be found in the Astor Library and the American Geographical Society's maps and atlases—that the root of the name America was widely scattered over Central and South America at the time of the conquest. It appears in the kingdom of Amarca, Caxamarca (or Peru), in Amaraca on the west coast of Central America, and in the forms Cundin Amarca (Bogota), Tamaraqua, Amaracapand, Caxamaraca, Andamaraca, Catamarca, and many others, applied to various places, which are indicated on the maps with which the pamphlet is illustrated. As the authorities for these statements are fully described and easily accessible, students have ample opportunity for verifying or refuting Mr. St. Bris's theory. In further confirmation of these views, M. Marcou asserts that Vespucci's name was Alberico, or Albert, and never Amerigo, till he had returned from his American voyage and had adopted or been given a name commemorating his travels.

Changes on the Zambesi.—According to the observations of British Consul O'Neill, of Mozambique, the Zambesi River is working out important changes in its course near Maruru. About six miles south of the position of his camp was a long, swampy lake, which once formed the course of the river. Some obstruction in the bed of the stream deflected its course to the northward, and the old bed was left as a still lake or backwater, which is now filled only from its eastern extremity. This alteration has made great havoc on the northern bank of the river, where the rush of waters has torn and continues to tear away the country which separates the Zambesi from the Mutu and Barabango and other swampy depressions that drain into the Quaqua or Quillimane River. A little more than two years ago the African Lakes Company purchased a house at Maruru which stood eight hundred or one thousand yards from the river-bank. When Consul O'Neill visited the place in April, 1884, the river was running swiftly past the front walls of the house, the foundations of which it had already sapped. The front rooms had fallen in, and only the back part of the house was habitable. These changes are destined, of course, to make considerable changes in the delta of the Zambesi, and in the depth of channels now navigable. No improvement has taken place in the method of navigating the Zambesi, and no attempt has been made to improve it since it was first ridden upon more than three hundred years ago. Boats which will just do on a still-water canal, have to be forced against a powerful current, "at times with oars, at times with paddles, at times pulled along shore with the crew harnessed to a rope, not unfrequently swept into mid-stream by the strength of the current, and turned like a top."

The American System of Water-Purification.—As described by Prof. Albert R. Leeds, this comprises three distinct features: artificial aëration under pressure; precipitation of dirt, sewage, hardening constituents, and coloring matters by harmless precipitants; and mechanical filtration through filters capable of rapid reversal of current, and cleansing by mechanical means. Artificial aëration was first applied to a city water-supply, by Prof. Leeds, in Philadelphia, in consequence of an extremely offensive taste and odor developed in the Schuylkill water, in January and February, 1883. This treatment has produced a marked improvement, as shown by analysis, in the quality of the water of a number of cities which have employed it, has corrected the offensive taste and odor, and has stopped the growth of green scum in reservoirs. His reasons for advocating the use of air under pressure are, first, because the disagreeable taste and odor in unpotable water are frequently due to gaseous and volatile impurities, which can be largely swept out of the water by the use of an excess of air acting mechanically as a deodorizer and disinfectant, thereby exerting a sweetening action in the manner of a water-scrubber; and, second, because chemical and biological analyses show that where sewage is being broken up it is in presence of large numbers of bacteria, which grow and multiply upon this material. Through the vital processes of these bacteria oxygen is rapidly absorbed and carried to the sewage, which is thereby broken up into nitrites, nitrates, carbon dioxide, and other partly or wholly oxidized compounds. After the work of these microbes is completed, they either perish or remain as resting spores, and then they should be removed, together

with the products of their labors, by filtration. Assisted precipitation is employed to remove suspended matters in very fine particles, the dissolved salts which make water *hard*, and coloring matters, especially the peaty substances that produce a dark-yellow stain. Sulphate of aluminum, or the ammonium aluminum sulphate, which is common alum, has been found to be the best precipitant for the suspended substances, forming with them an insoluble coagulum. One grain of alum to the gallon is ordinarily sufficient, and this has no deleterious effect on the water. The insoluble clot which it forms carries down with it the products of putrescent decomposition which are present, and the microbes, or so-called disease-germs. For softening hard water, the precipitant used is lime, the lime carbonate thrown down being removed by filtration. The only material yet found to be available for filtration on a large scale is fine sand. In order to avoid the expense of the system of sand filtration, which has long been employed in England, a mechanical contrivance, called the National Filter, has been devised in this country. The filter consists of a closed tank, two thirds full of sand. The water enters at the top of the tank, filters downward, and escapes by a perforated pipe at the bottom. To clean the filter, a reverse current is sent in by a perforated pipe lying about a foot below the surface of the sand, most of the dirt being deposited in the upper six inches, and the water, after taking up the impurities, escapes by an outlet at the top. A reverse current is then sent through the sand by the perforated pipe at the bottom. Every portion of the bed is floated loose, and by the attrition of the grains of sand upon one another the impurities are scrubbed off; they are then floated to the top, and carried away. When the cleansing is complete, the reverse current is shut off, and the sand settles down into a fresh, uniform filter-bed.

The English Glacial Moraine.—Prof. H. Carvill Lewis's studies of the glacial terminal moraine of England were based upon the principle that every glacier, at the time of its greatest extension, is bounded and limited by a terminal moraine. The great ice-sheet which once covered northern England was found to be composed of a number of glaciers, each of which was bounded by its own lateral and terminal moraines. These glaciers were studied in detail, as the North Sea glacier, the Wensleydale glacier, the Stainmoor glacier, the Aise glacier, the Irish Sea glacier, the separate Welsh glaciers, each of which was found to be distinguished by characteristic bowlders, and to be defined by a well-marked moraine. The great terminal moraine of the united glaciers of England is a very sinuous line, five hundred and fifty miles in length, extending from the mouth of the Humber to the farthest extremity of Carnarvonshire; and, except where it separates the Welsh glaciers from the North Sea glacier, it everywhere marks the extreme limit of glaciation in England.

The "High-Altitude" Cure for Consumption.—In contemplating the resort to a high altitude for treatment of consumption, which is now becoming common, it is well to consider whether the constitution of the patient is adapted to the conditions that he will meet there. From the fact that the atmospheric rarefaction at elevated positions throws a greatly increased strain upon the circulatory apparatus, we have a right to regard valvular disease of the heart or feeble circulatory power as a strong contra-indication against trying the high-altitude treatment. For a similar reason that treatment is inapplicable to persons of advanced age, in whom the arteries are likely to have undergone more or less of senile degeneration. As the rarefaction of the air increases the number and depth of the respirations and promotes the elimination of carbonic acid from the lungs, it is not adapted to cases in which the lung-tissue has been much destroyed. Although superficial effusions of blood are sometimes suffered at great heights, bleeding at the lungs has not been observed there, and the danger of it is not believed to be increased. The prevalence of cold at high altitudes is a fact to be considered by persons whose sufferings are increased by low temperatures. The combination of cold, dryness, and rarefaction constitutes a climate of a highly stimulating character. It is consequently exciting, and unfavorable to nervous persons, while it may be beneficial to the phlegmatic. The cases

that do best at high altitudes are those of simple phthisis, in patients who are free from cardiac, renal, or rheumatic complications, and who exhibit a torpid reaction to the disease.

Increasing the Tractive Power of Locomotives.—Patents were granted in March to Elias E. Ries and Albert H. Henderson for methods and apparatus for increasing the tractive power of locomotives and other self-propelled rail vehicles. This is accomplished by increasing, by means of electricity, the frictional adhesion between the driving-wheels and the rails. The apparatus consists of a dynamo-electric machine on the locomotive, from which a current of electricity passes through a converter, and thence through the driving-wheels in succession and that portion of the rails between them. Further, the current, which is of great volume and small motive force, is said to cause enough heat at the point of contact to vaporize at once any moisture on the rails, thus overcoming the slipperiness caused by snow and sleet. The inventors claim that, by their plan, the tractive power can be nearly doubled without increasing the weight of the locomotive, that a 40-per-cent grade can be more easily surmounted than a 7-per-cent one under the old system, that trains can be stopped and started much more quickly than at present, and that the friction obtained is cheaper than sanding, without its consequent wear.

An Exhibition of Insects.—An exhibition of useful and injurious insects was held in Paris a short time ago, at which five hundred entries of objects were made. Great pains were taken to awaken interest in it. Prizes were offered to school-children for the best compositions on their visits to it. Conferences were held in the rooms on questions relating to the study of insects. Medals were offered to rural teachers who sent collections gathered by themselves or their pupils. Booksellers offered books to those who sent the best collections and the best papers on entomology. Anatomical preparations were shown by Dr. Ozouf representing the organization of the silk-worm in its several states and of May-bugs; silks from Tonkin and Senegal; oak silk-worms raised in the open air which furnish a silk identical with the Chinese pongee; living ant-hills collected by M. Morel, a journeyman painter; ant-lions which had excavated their dens in the sand as if they had been in the woods; batrachians, lizards, adders, aquatic insects, wasps building and repairing their nests, bee-hives with windows through which the bees could be seen at their work; wasps' nests from Senegal, remarkable for their excessive hardness; gall-nuts of various kinds, and collections from several countries, with illustrations of various features of insect life and economy.

Construction of Mythologies.—Closely connected as mythology and folk-lore are shown to have been, says Mr. J. A. Farrer, it is difficult or impossible to say in any given case whether the superstition is derived from the myth or the myth from the superstition. The usual method of interpretation deduces superstition from mythology, making the latter the primary starting-point. But it is often quite as likely that the custom was there first, and that the myth made use of already existing customs; for instance, that the horse figured conspicuously in legend because it had long been an object of worship or superstition, is as likely as that it became an object of worship or superstition because it figured so conspiculy in legend. The horse is thickly set in folk-lore. In parts of Germany a horse's head may still be seen over the doors of cattle-stalls or about the houses — a custom which survives among ourselves in the luck attaching to a horse's hoof. This, perhaps, dates from the custom of our ancestors, mentioned by Tacitus, of keeping white horses in sacred groves at the public expense and idle, and forecasting the future from their neighings. A horse's neighing always presaged victory to a warrior, as his silence presaged defeat, and the French anticipated disaster at Agincourt from the fact of their horses not neighing on the eve of the battle. A horse's hoof under a child's pillow is supposed to be a preventive from convulsions, a horse's teeth are a safeguard against toothache, and houses at which they shy are threatened with calamity. There is no reason to look for any more abstruse explanation for the part which animals, birds, fishes,

and insects play in the tales of the gods and heroes, than the fact that they were already accredited in popular superstition with the powers which they display in the stories. Seeing how many of the European peasantry still construct mythologies in an old-fashioned way, and cling to the old views in spite of science, we should have less difficulty in believing that the Greeks and Hindoos originally proceeded in the same fashion, without that constant reference to the struggle between light and darkness which some writers ascribe to them.

NOTES.

THE Entomological Club of the American Association will meet at 9 A. M., August 15, 1888, in the High-School building in the city of Cleveland. As Cleveland is quite centrally located, this will be very convenient both for Canadian and United States entomologists. We may therefore expect an unusually large and interesting meeting. All who expect to present papers should send notice of their subjects to A. J. Cook, Secretary, Agricultural College, Mich.

THE meeting of the British Association is to be held at Bath, beginning September 5th. The sectional presidents will be Prof. Schuster in Mathematics, Prof. Tilden in Chemistry, Prof. Boyd Dawkins in Geology, Mr. Thiselton Dyer in Biology, Colonel Sir C. W. Wilson in Geography, Lord Bramwell in Economic Science and Statistics, Mr. W. H. Preece in Mechanical Science, and General Pitt-Rivers in Anthropology.

THE College of Engineering, of the Imperial University of Japan, graduated nineteen students in 1887—a number which the president thought, in view of the facilities for study offered, ought to be and would be much exceeded this year. There were four graduates from the College of Science. It appears that the people of Japan have not yet realized what promising careers are open to their young men in science. The small numbers which the scientific departments of the university are graduating are insufficient to meet the demands, which are increasing year by year, for the services of scientific men who shall further the national progress. Meanwhile, it is impossible to fill many vacant positions in the offices of the Imperial Government, and in various local governments and schools, where such graduates are needed.

DR. LUDWIG WOLF reports that the Baluba, of Central Africa, do not see any wrong in selling their wives and children, but that they make a difference between domestic slaves and slaves for export. A Baluba chief, with whom he expostulated, listened quietly to his arguments, and then told him, rather in confidence, that they sold only their troublesome wives out of the country, never the good ones. Dr. Wolf saw in the slave-market at Mukenge a distinguished-looking old fellow who had been a chief. During his reign he was continually fighting with the neighboring tribes, and many of his subjects were killed in battle. At last his people began to grumble, and decided quietly to sell their own chief into slavery, as the best way to get rid of him, and to live for the future in peace. They sold him for ten goats, which were killed, and the meat distributed as a compensation among the relatives of those who had died in the frequent battles of their chief.

MR. J. A. SCOTT, of Ann Arbor, Mich., has had a pleasant experience in tree cultivation during his life of eighty years. He can point to trees in Connecticut, now two feet in diameter, which he planted when a boy. His present home is shaded with a grove of maples which he planted. He allows squirrels to frequent the place, and encourages them to stay. They bring nuts, some of which find their way to the ground and grow; and thereby the maples are becoming interspersed with nut-bearing trees, which are already from six to twelve inches in diameter.

A CONTRIBUTOR to "Land and Water" mentions having shot in the Crimea bustards which came to the shore over the water from the southward, and alighted very weary. The circumstances indicated that they had flown across the Black Sea, and confirmation of this belief was given by finding in their crops a species of dwarf bean which was not known to grow nearer the Crimea than upon the hill-sides of Asia Minor, around Brusa, almost three hundred miles distant. He also took in the hand several quails, very much exhausted, which had apparently come direct from the sea.

EARTHQUAKE recorders have been so adjusted at the observatories in Japan as to give correct graphic representations of the movements undergone by a point on the soil during the progress of a shock. The resultant figure exhibits a series of twists and wriggles of the most complicated kind, so that the path pursued by the point might be, as it has been, compared to the form taken by a tangled string when thrown down in a heap. Prof. Sekiya, of the University of Tokio, has deciphered one of these tangles, and has made a model of seventy-two seconds of it in wire, in which the line of the curve of motion is distinctly designated for each second. The model, ten times the size of the graphic representation, is divided, to save confusion of the eye and mind of the student, into three sections, which are separately mounted, but fixed on a common table.

THERE are important differences in the quality of the virgin pine-wood of Michigan and the second-growth pine of Massachusetts. As shown by Mr. E. K. Lake, of Lansing, the virgin pine from Michigan is tough, and breaks splintering for three or four inches, while the second-growth wood from Massachusetts is more brittle and less fibrous, and breaks off short and even. The difference is ascribed to the more rapid vegetation, following the more direct exposure to the light, of the Massachusetts second growth; and also to the more perfect maturity of the Michigan pine—the specimen exhibited having been eighty years old when it was utilized, while the Massachusetts pine was cut at the age of forty years.

DR. GEORGE HARLEY, F. R. S., has made an investigation which reveals abundant evidence to prove that although man, during his evolution from barbarism to civilization, has increased in strength and stature and in longevity, on the other hand, his power of recovery from the effects of bodily hurt has materially deteriorated.

The existence and persistence of exclusively local customs—that is, of customs prevailing in a single village, without extending to those immediately around it—is a phenomenon for which explanation is still wanting. An instance of the kind has been marked at Wurzen, on the borders of Carniola, where, whenever there is a baptism, the nurse, on leaving the house to go to the church, takes a loaf of bread with her, and gives it to the first person whom the party meets. It is understood that the person to whom it is offered must take it whether he wants it or not. The custom is said to be symbolical, and to be intended to make the child charitable. But why has it been preserved here so long, while no other village has it?

A PRACTICABLE method of promoting forest growth is advocated by Mr. L. D. Watkins, of Michigan, by covering the waste places on the farm with trees. Besides making the land of use and being commercially valuable, they would serve a good immediate purpose as screens. The author recommends the common locust for steep hill-sides, where nothing else can be grown; black-walnut and white oak for such spots as may be fertile; and cedar and tamarack (larch) for damp, springy place.

THE reports of the British Meteorological Office show that the mean rainfall for the whole of the British Islands during 1887 was only 25·8 inches, whereas the mean for the twenty-two years from 1866 to 1887 was 35·3 inches. Thus there was a deficiency over the whole area of the country of nearly 10 inches, or 27 per cent.

DR. THORNE THORNE has called attention to the gradual decline of small-pox in England during the past fifty years. In the five years from 1838 to 1842, the deaths from this disease amounted to 57·2 per hundred thousand living, while in 1880–'84 the death-rate had sunk to 6·5 per hundred thousand. It is believed that vaccination has not only had a direct influence in causing this marvelous reduction in the number of victims to small-pox, but has also had a tendency to make the children of vaccinated parents less liable to the disease.

OBITUARY NOTES.

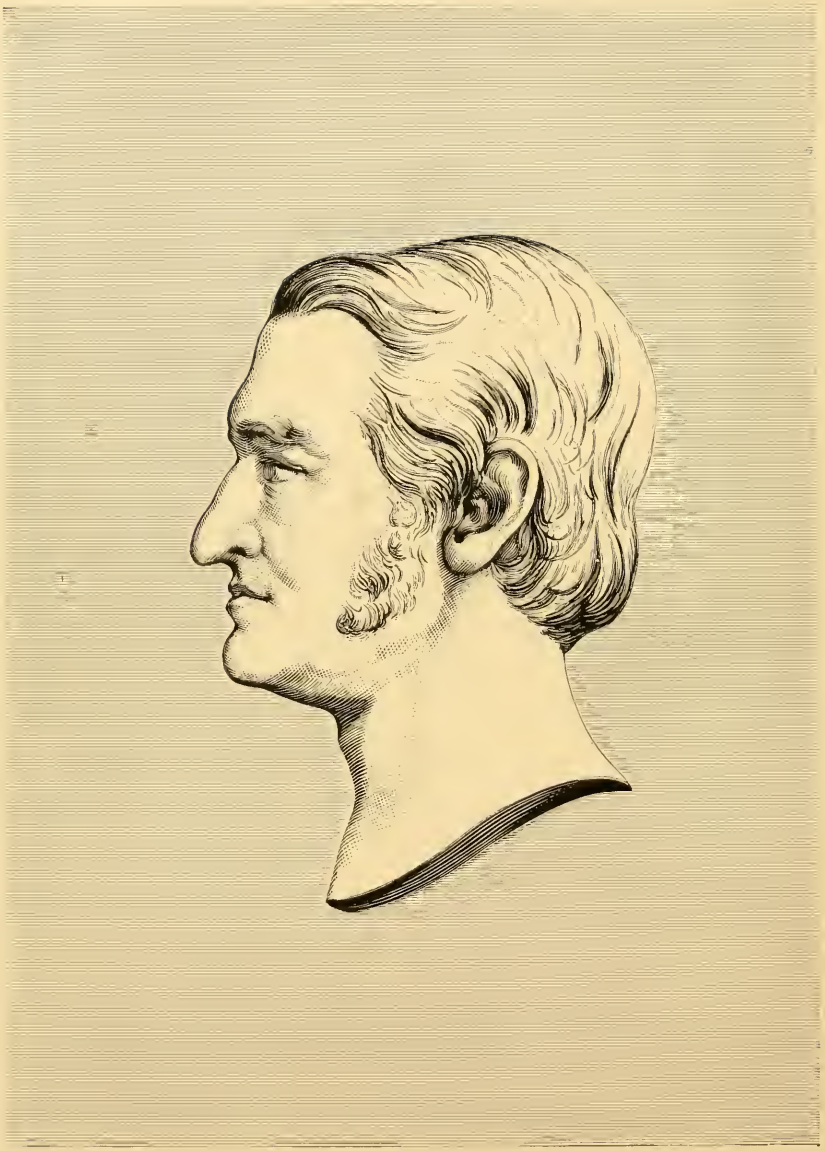
PROF. M. N. BOGDANOFF, an eminent Russian zoölogist, died at St. Petersburg, March 16th. He was the author of several works, relative to the animal life of different parts of Russia, in one of which he treated in detail the present geographical distribution of animals in connection with the soil and climate of the country during the Post-Pliocene period. His "Birds of the Caucasus" is the authority on that subject. In 1885 he began the publication of what was to have been his chief work, the "Ornithology of Russia." Only the first part of it has been issued. He was also the author of popular zoölogical sketches, published in a periodical.

V. N. MAINOFF, an eminent Russian ethnographer, has recently died. He was best known for his studies of the Mordvinians, their anthropological features and customs. He also prepared a Finnish grammar, and was compiling a Finnish and Russian dictionary.

JAMES JOHONNOT, a well-known laborer in education and author of educational books, died June 18th, at Tapton Springs, Florida, aged sixty-five years. His work in education was begun when he was eighteen years old, and was continued as teacher and institute instructor till 1885, and as author as long as his health permitted. Among his educational works, many of which were drawn from science, and in effect were first steps in it, are the "Principles and Practice of Teaching," the "Geographical Reader," the "Natural History Series of Instructive Reading Books," six in number; "How we Live," an elementary physiology; the "Historical Series of Instructive Reading Books," seven in number; and the "Sentence and Word-Book."

MR. HENRY PRYER, an authority on Japanese entomology and ornithology, died at Yokohama, February 17th. He was an old resident in Japan, and spent most of his time in business pursuits, while he also made a name in science.

PROF. R. D. IRVING, of the United States Geological Survey, died May 30th, in the forty-second year of his age. He had charge of the surveys in Wisconsin and Minnesota.



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THE GROWTH OF JELLY-FISHES.

A CHAPTER IN THE NEW ZOÖLOGY.

By Professor W. K. BROOKS,
of Johns Hopkins University.

I.

ON any landlocked and sheltered sea-beach, where the waves ripple up on to the sand without breaking, hundreds of small spiral sea-shells may usually be found in the shallows dancing up and down the sand at the water's edge, following the crest of each little wave as it flows up and spreads out over the beach, and turning to run back with it as it falls; keeping always just within the water, and exhibiting restless activity and agility, quite unlike the sluggish habit of the snails which normally inhabit the shells.

If the loiterer by the waves should be inquisitive enough to be attracted by them, and should search for the meaning of the unusual liveliness of the snails, he would find that each shell is inhabited by a hermit-crab, that, after devouring the true owner of the house, has thrust his own body into it, and carries it about, as a defense against his many enemies, among whom his pugnacious and cannibal brothers and sisters are perhaps the worst.

So much the most superficial observer may discover for himself; but if, with a naturalist's sharp sight and thirst for knowledge, he examine more closely, he will find that about one in a dozen of the shells is coated, upon the surface which is uppermost as the crab carries it, by a white crust of a mossy substance which is not found upon the empty shells which lie on the bottom, nor upon the shells of living snails. If, impressed by this odd fact, he detach a little of the moss and examine it under a microscope, in a watch-glass filled with sea-water, he will find that it is

a most remarkable and interesting community of minute animals, a polymorphic hydroid colony, well worth most exhaustive investigation. Several species and genera of hydroids are found upon the shells of hermit-crabs, but they are usually pretty much alike in general organization; and our Fig. 1, which is a highly magnified drawing of a small portion of a colony of the hydroid larvæ of *Dysmorphosa,* will serve to represent their character.

The crust on the surface of the shell consists of a network of tubes, cemented to the shell and to each other in a mass from

FIG. 1.

which the bodies of the individual hydras protrude, somewhat as the stem of a tree rises erect from the creeping root, although the community is more like a thicket of suckers than a single tree, for all its members spring from one system of roots, and, although

they may be numbered by hundreds or even thousands, form one continuous organism.

The stomach of each member of the colony is directly continuous with the hollow roots, and, through these, with the body of every other member, and any food which is captured and digested by one, serves to nourish all, since it circulates everywhere through the roots, as water flows through the mains to all the houses in a city.

The whole is the result of multiplication by buds, and all the members are derived from one, which hatched from an egg, and, fastening itself to a shell, founded a new colony. A new bud may grow out anywhere, from the roots, and as the current of food which is always sweeping by provides it with ample nourishment, it grows quickly, and the repetition of the process of budding brings about a rapid increase in the size of the community.

The existence of a mechanism for propelling food to all its members facilitates the division of labor, or polymorphism, which is the most remarkable characteristic of these hydroid communities. In human history the growth of agriculture has supplied the first need of all men, abundant food, by the labor of a few, and has thus rendered division of labor possible, and has permitted many persons to train and qualify themselves for many pursuits which do not contribute to the food-supply. The existence, among the hydroids, of a mechanism for feeding them independently of their own efforts, has permitted the same sort of specialization to grow up, and even to become more perfect in some respects than it is among mankind.

The welfare of any species requires that the individuals shall be supplied with food, protected from accidents and enemies, and enabled to reproduce the species, and while many parasitic animals, and the young of many others, are supplied with food without exertion, the conditions of their life do not usually permit much specialization, and this does not, as a rule, occur unless the individuals of the species form communities. The social ants and bees are divided into castes, and the existence of hydroid colonies, which are structurally united into compound organisms, presents the conditions which are most favorable for specialization among the members of the community. We accordingly find among them the most remarkable examples of division of labor, accompanied by structural specialization or polymorphism.

A young dysmorphosa colony consists of a creeping root, which carries a number of hydras, all of them like *a* in the figure. They are the eating and digesting members of the society. Each of them has a long tubular body, almost completely filled by a capacious stomach, which opens to the exterior, at the free end of

the body, through a mouth which is mounted upon a short, flexible proboscis, and is surrounded by a circlet or crown of long, elastic tentacles, radiating out in all directions around the mouth, and fringed by a poisoning apparatus of microscopic darts, which kill all the small animals which venture within the sweep of the tentacles. The food that is thus captured is conveyed to the mouth, and is swallowed and digested.

As the colony grows and the feeding members become numerous enough to store up a stock of nutriment and to bear the burden of a few non-productive parasites, hydras like *b* in the figure are produced. They are the fighting members, and have neither mouths nor stomachs, but each consists of an enormously elongated body, which ends in a battery of poison-darts, which is comparable to a circlet of undeveloped tentacles. The entire body of one of these fighting hydras is practically equivalent to a single enormous tentacle, although comparative anatomy shows clearly that it is not a tentacle, but that it corresponds to the whole body of a feeding hydra, tentacles and all, rather than to a single tentacle; that it is actually a hydra which has, during the evolution of the species, lost its mouth and stomach, and its power to capture and swallow food, and has become specialized for defense. These long, slender, outstretched bodies project far beyond the other members of the colony, and their poison-batteries wave in all directions over the heads of the feeding hydras. The shock of contact with them is either fatal or violent enough to paralyze any intruder, or to cause it to beat a hasty retreat.

As the community gains in numbers and strength, buds of a third sort are produced from the root, and become the reproductive hydras or *blastostyles*, which are shown at *c* in the figure. They are much like the feeding hydras in shape and in general structure, but the tentacles remain rudimentary throughout their life; they have no mouths, and their capacious stomachs do not open to the outer world, although their walls vigorously assimilate the food which flows into them through the roots.

As soon as the blastostyle is fully grown, a circlet of buds grows out from its body, just below its rudimentary tentacles. These buds soon acquire an organization which is very different from that of any of the forms which have been described, and, developing organs of locomotion, are ultimately detached from the blastostyles, and are set free to begin their independent life as solitary, swimming jelly-fish, like those which are shown at *d* in the figure.

The active jelly-fish is as different from all the members of the hydroid colony as a butterfly is from a caterpillar. When fully grown it is vastly larger than a hydra, and it has a well-developed swimming apparatus, which is under the control of a

nervous system, which again is brought into relation with the external world by means of special sense-organs. It is a gelatinous bell, from the inner surface of which the pendent stomach hangs down like the bell-clapper, while the long, graceful, thread-like tentacles are attached at regular intervals around the opening of

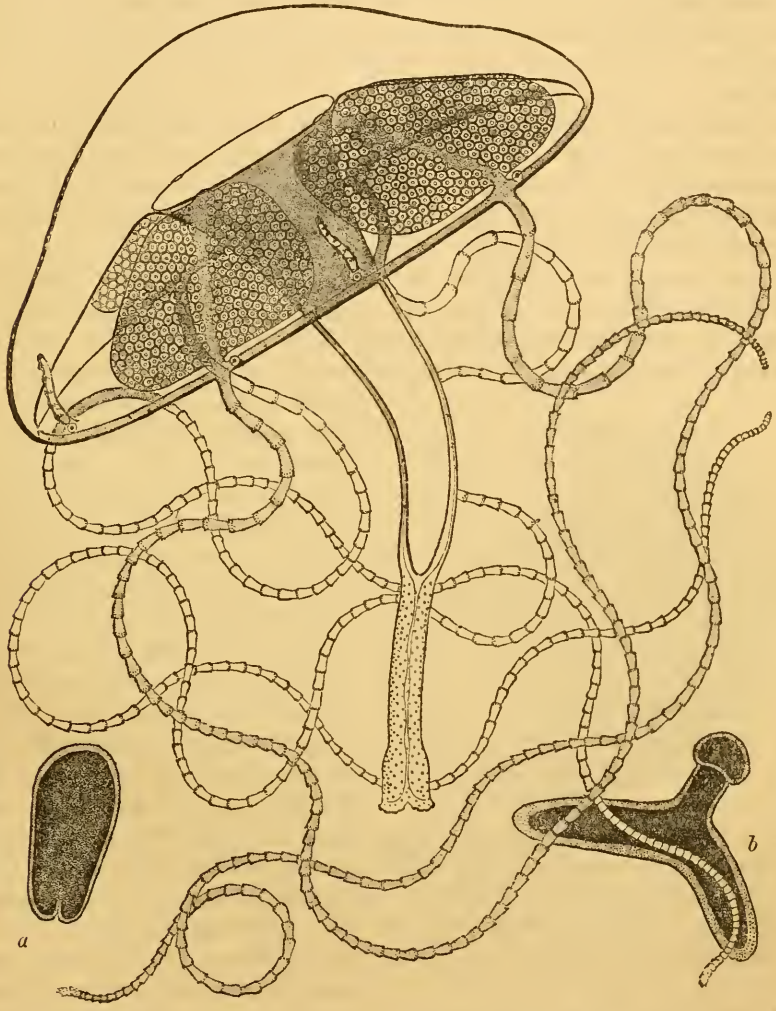


FIG. 2.—*Liriope scutigera*, slightly magnified, drawn from Nature by W. K. Brooks. (The small figure in the left-hand lower corner is the planula of Turritopsis, greatly magnified; and the one in the right-hand corner, the root and the first bud of the Turritopsis hydroid.)

the bell. The locomotor muscles are so distributed over the inner surface of the bell that their contraction squirts out the water in a jet which propels the animal in the opposite direction; they are then relaxed, and the elasticity of the gelatinous substance of the wall of the bell causes it to expand and to draw in another supply

of water which is discharged by the next muscular pulsation. The tentacles are so elastic and hair-like that they are held by the resistance of the water, and are drawn out behind the animal into fine glassy threads which are thrown into graceful undulations at each pulsation as it swims through the water, and, when it comes to rest and sinks slowly toward the bottom, they form a web or net which is almost invisible, but far more dangerous than any spider's web, for every thread is covered with the terrible poison-darts.

Great as the difference is between the sedentary hydra and the swimming jelly-fish, comparative anatomy shows that they are modifications of the same type, and that the jelly-fish, like the blastostyle, the defensive hydra and the root, is a specialized feeding hydra.

In some species of Dysmorphosa the jelly-fish which is set free from the blastostyle is the last stage in the long series, and it quickly acquires reproductive organs, lays its egg or discharges its spermatozoa as the case may be, and dies; but in other species it no sooner begins its own independent life than it produces buds which are ultimately set free, as jelly-fish like the parent, each of which soon becomes a mature male or female. The eggs are thrown out into the water, where they are fertilized by union with the male cells, and each egg then begins the process of development, which is to result in the founding of a new hydroid colony. The life of the jelly-fish is very short, and simply serves to multiply the species, and to scatter the eggs far and wide along the shore of the ocean, and thus to secure the wide distribution of the hydroids. The egg hatches, however, neither into a jelly-fish like the parent, nor into a hydra, but into a minute microscopic animal of extremely simple structure, which is known as a *planula*. Fig. 2, *a*, which is a highly magnified drawing of the planula of another species, will serve to show what it is like. It has no mouth nor tentacles, and its pear-shaped body is covered with cilia, by means of which it swims slowly through the water for a short time, but, unless its slight locomotor power soon brings it into

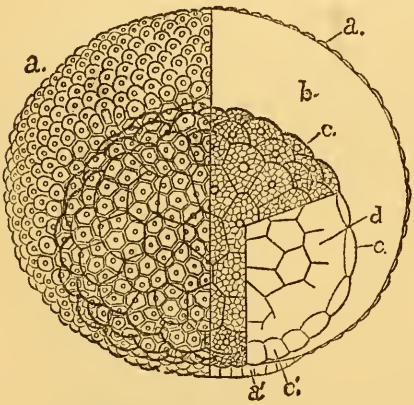


FIG. 3.—Planula of *Lirtope scutigera*, highly magnified. drawn from Nature by W. K. Brooks: *a*, surface layer of cells, which is shown in section on the right half; *b*. gelatinous substance; *c*, inner layer of cells, shown in section in the lower right-hand quadrant; *d*, the central cavity; *a'*, the point where the mouth is to be formed.

contact with some solid body upon the bed of the ocean, it dies. With the discovery of a solid resting-place its purpose is accomplished: it loses its cilia, and, cementing its body fast, it elongates and becomes converted into a root, from which the bud which is to form the first feeding hydra soon arises, and, acquiring a mouth and tentacles, begins to accumulate food and to provide for the growth of a new colony. In some other species the planula becomes a feeding hydra instead of a root, and the history of the various hydroids shows clearly that the root is directly comparable with a hydra and is a member of the community which, like the others, is specialized for a particular purpose.

On a sea-beach there are few hard solid bodies except the shells of mollusks, and these are therefore the only available resting-places for the planulæ, but a colony which is founded upon the shell of a living mollusk has no chance of prosperity, for the mollusk is sure to soon plow its way under the sand or into the mud, and a delicate hydroid can not survive such rough usage, nor is the case of a planula which finds an empty shell any better, for the first storm will either bury it under the sand, or toss it high and dry above low-tide mark, or sweep it off into some deep channel to be buried under the mud and sediment.

Everything is favorable to the new colony which is started on a shell which a hermit-crab has selected for a house, and the chances are that it will grow and prosper and soon become a vigorous, flourishing settlement; for the crab does not creep like a snail, but trots around on the tips of his claws with the shell held well up above the sand, and he is far too intelligent and wide-awake to permit himself to be stranded on the beach, or swept away into muddy quicksands. As the gentle waves ebb and flow on the shore he follows them back and forth, keeping close to the edge, where the food which is washed out of the sand is most abundant and the aëration of the water most perfect. As long as the sea is calm he may be trusted to carry his load of hydroids into the places which are most favorable for them, and as soon as a storm approaches he trots off with his charge to a safe shelter in deeper water and waits until it has passed. A colony which is founded on his shell is sure to flourish and increase, for this location affords all the elements of prosperity, and, while small colonies are often found in other places, the most vigorous and largest ones are, as a rule, found only in this peculiar habitat.

In the following diagram I have attempted to exhibit at one view all the phases in the remarkable life-history of Dysmorphosa. The sign of equality = between two stages indicates that the one on the left becomes transformed into the one on the right, without multiplication and without loss of identity; the sign × indicates

asexual multiplication by buds, and the sign < sexual reproduction by fertilized eggs:

I. Dysmorphosa.
Egg=Planula=Root ×
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,
- ×
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,
- ×
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,
- ×
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,
- ×
- Feeding hydra ×
  - Feeding hydra,
  - Blastostyle ×
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
    - Medusa ×
      - Medusa < eggs.
      - Medusa < eggs.
  - Fighting hydra,

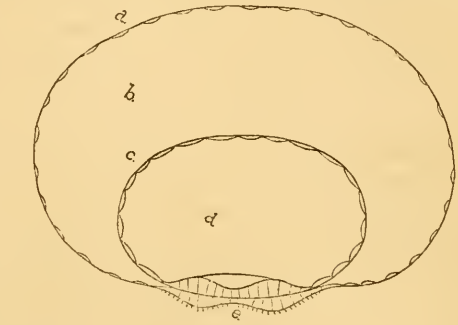
The egg hatches into a planula, which becomes attached and is *converted* into a root, from which feeding hydras *bud;* from the roots of these feeding hydras, other feeding hydras, and, after a time, defensive hydras and blastostyles or reproductive hydras, are budded in very great numbers, and, while the diagram correctly represents the complexity of the colony, it conveys no conception of its size or of the number of its members. Each blastostyle produces a considerable number of buds, which are ultimately set free as swimming jelly-fish or Medusæ, and each medusa multiplies by budding, and thus gives rise to a second generation of Medusæ, which probably repeat the process in their turn, so that a very great and practically unlimited number of sexual egg-producing adults results from a single egg.

What a contrast between the direct and simple history of ordinary animals, where each adult is the total progeny of the egg, and such a life-history as this, where the egg not only produces an unlimited number of sexual adults able to bud off others like themselves, but also gives rise to an innumerable number of larvæ which never become sexually mature nor assume the adult form.

Those who are familiar with the subject know how much paper and ink have been wasted in discussing the individuality of hydroids, but we need not enter into into this dead issue, for, beyond question, each feeding hydra, each defensive hydra, each blastostyle, and each jelly-fish is an individual in the same sense that a horse or a dog is one; and the most remarkable peculiarity of Dysmorphosa is the enormously great number of descendants from each egg. Another peculiarity must also be noted. The life-his-

tory is not a simple process of growth, nor a metamorphosis, like that which occurs among insects.

The caterpillar, which hatches from the butterfly's egg, is perhaps as unlike the butterfly as the hydra is unlike the jelly-fish, but it never loses its identity, and the individual which hatches from the egg is the same one which passes through all the caterpillar molts, becomes a chrysalis, and finally escapes as a perfect butterfly, just as the chick which hatches from a hen's egg is the individual which finally becomes a hen and lays eggs in her turn. The growth of the butterfly is accompanied by great and sudden changes from one stage of development to another, but it is simply a process of growth and development, while the life of Dysmorphosa is quite different. The planula, which hatches from the egg, becomes metamorphosed into a root, just as the caterpillar becomes changed into a chrysalis; but here the resemblance stops, for the root goes no further, and it may still remain a root after numbers of jelly-fishes have grown up, laid their eggs, founded new colonies, and died. The feeding hydras and defensive hydras never grow up into jelly-fish, but, as long as they live, continue to perform their proper parts in the colony, and this is equally true of the blastostyles, for these do not become jelly-fish; they simply produce jelly-fish buds, and each one may persist as a blastostyle and continue the process of budding long after the younger buds have completed their history.



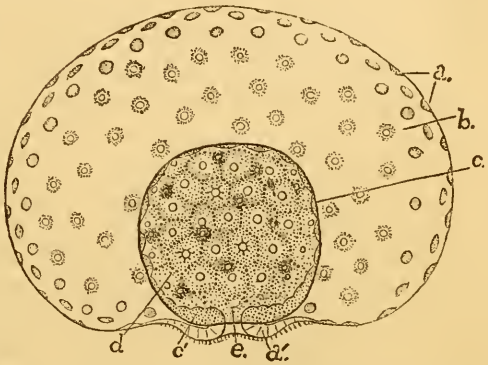


FIG. 4, a section, and Fig. 5, a surface view of the larva of Liriope, to show the formation of the mouth, *e*, and the stomach, *d*.

In all these particulars the life of Dysmorphosa is a great departure from the normal life-history of animals, for, as a rule, each embryo which hatches from an egg is destined to become an adult animal, and only one.

The simpler aspects of the phenomena of life are older or more

primitive than their more complex manifestations, and all analogy forces us to believe that Dysmorphosa is the descendant of some remote ancestor whose life-history was as simple and direct as that of a bird or a mammal or a frog, a butterfly, a snail, a crab, or a star-fish, and that originally each egg became converted into an adult by growth and metamorphosis.

If this is true, how has its complexity arisen? What were the stages in the gradual acquisition of the life-history which is shown in our diagram? What forces have produced the change, and what is its significance or advantage?

Not very long ago such questions were held to be unanswerable and meaningless, but at the present day we are all familiar with the process of reading the past history of life by the study of comparative anatomy and embryology, and are ready to accept the evidence of the series of living hydroids which show us the character of the changes through which the ancestors of Dysmorphosa have passed, as they have gradually acquired the structure which is exhibited by their living descendants.

I shall now briefly describe a few American species of jelly-fish, which exhibit successive stages in the process of complication, and serve to show that the remote ancestor of Dysmorphosa must have been a jelly-fish, which passed, during its development, through a transitory larval hydra stage, which was only a step in the process of growth of the embryo into an adult. In this form each egg produced one animal; the adult life was all-important, and the hydra stage was passed as quickly as possible; and during the history of the species this has gradually become a more and more important part of the whole life, until finally the adult jelly-fish has become comparatively unimportant and simply serves to secure the distribution of the species, while the larvæ have acquired the power to bud and to build up colonies, the members of which have become specialized in various directions, by division of labor, for the benefit of the whole.

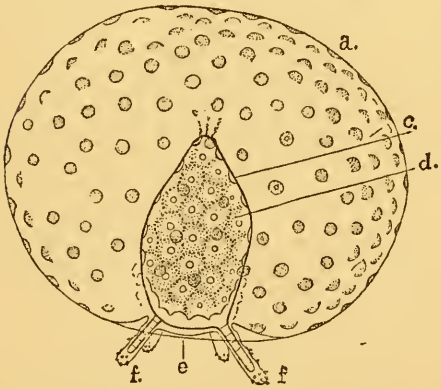


Fig. 6.—Hydra stage of the larva of Liriope: *d*, stomach; *c*, mouth; *f*, tentacles.

One of the most graceful *Medusæ* of our Southern coast, from Florida to the Chesapeake Bay, is the beautiful Liriope shown, somewhat enlarged, in Fig. 2. It is not very different from Dysmorphosa in shape, but it is much larger, and a most active and

elegant creature, with a bell like cut-glass, and long, waving tentacles. Its movements are so instinct with grace that an admirer of the lines and curves of Nature could desire no better or more fascinating occupation than the observation of an aquarium stocked with a few specimens of this attractive jelly-fish. The drawing is accurate, so far as mere shape goes, but no drawing can represent its jewel-like brilliancy or the elegance of its movements. Its chief interest to us, however, centers in its life-history, which is very different from that of Dysmorphosa. Its proper home is the deep water of mid-ocean, not the shallows near shore; and it has no attached stage of development, but floats or swims at all periods of its life. The eggs are thrown out into the water, and each one soon develops into the embryo which is shown, highly magnified, in Fig. 3.

This embryo, which is a planula adapted for floating instead of swimming, is a hollow sphere, the walls of which are formed of

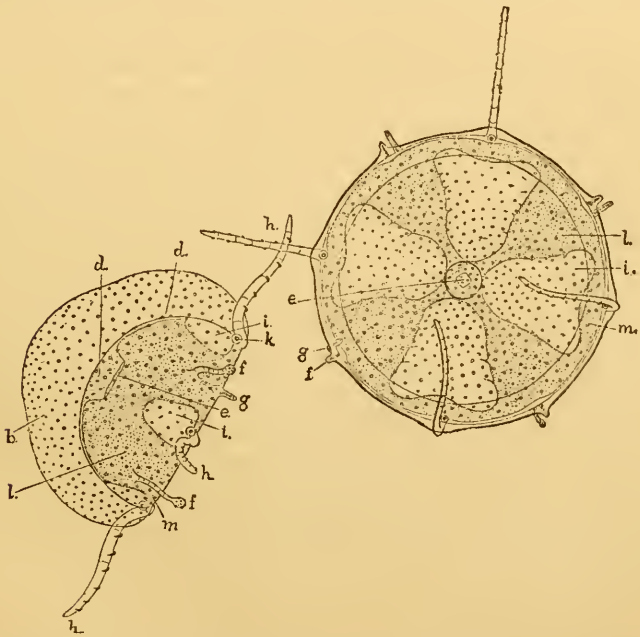


FIG. 7, side view, and Fig. 8, a broad view of a young Liriope: *b*, swim-bell; *d*, stomach; *e*, mouth; *f*, larval tentacles; *g*, long tentacles of adult; *h*, short tentacles of adult; *i*, areas of adhesion; *k*, otocysts; *l*, radial canals.

two spherical shells, an outer one, *a*, which forms the surface of the body, and an inner one, *c*, which lines the central cavity, the two being separated from each other by a gelatinous layer, *b*, which serves to float the embryo in the water. The central cavity has at first no opening to the exterior, and the two shells are concentric, but they soon approach each other at a point, *a'*, and

an opening to the exterior is formed. The central space now becomes the stomach, *d*, in Figs. 4 and 5, and the opening becomes the mouth, *e*, in Figs. 4 and 5. Soon after the mouth is formed a circlet of tentacles is developed around it, and the larva becomes a hydra, but a hydra adapted to a floating life rather than a fixed life, as shown in Fig. 6.

It is now able to capture and digest food and to lead an independent life, and it grows rapidly, although it has as yet no locomotor organs, and drifts at the mercy of the waves.

Soon the stomach becomes flattened and the mouth pushes in toward the center of the sphere, carrying with it the surface layer of cells, and thus giving rise to a concave, hollow bell-cavity opening to the exterior, as shown in Fig. 7, in which *d* is the flattened stomach, *e* the mouth, and *f* the cavity of the swim-ball.

As the mouth is pushed in, the tentacles are left behind and remain on the edge of the bell in the position which they occupy in the adult. The animal grows rapidly, the tentacles lengthen, and, after some slight changes which do not now concern us, the larva becomes converted into an adult, like the one shown in Fig. 2, and again reproduces its kind by fertilized eggs.

The life-history of Liriope is simple and direct. There is a metamorphosis, and the animal passes through a planula stage, a hydra stage, and a medusa stage; but its identity is never lost, and the larva is the same individual as the adult, as is shown in the following diagram:

II. Liriope.—Egg = Planula = free Hydra = Medusa < eggs.

Although most of the text-books state that the direct history of Liriope has been produced by the gradual simplification of a complicated life-history like that of Dysmorphosa, there is no evidence whatever that this is the case, and the fact that the development of Liriope resembles that of all ordinary animals is in itself an indication that its simplicity is not secondary but primitive. This view is rendered still more certain by the study of other jelly-fishes which exhibit successive steps in the process of complication.

Dr. Karl Pettersen, Director of the Tromsö Arctic Museum, has suggested that the object of polar expeditions could be obtained most easily, surely, and cheaply, by dispatching, instead of single sporadic expeditions, every year, for a period of ten or eleven years, a number of well-equipped steamers from certain suitable points toward the pole. Amid the ever-varying shifting of the polar drifts and currents, some of these vessels might possibly get through. He recommends four points of departure for such vessels: one along East Spitzbergen and Franz-Josef Land, and northward; one east of Franz-Josef Land, from the Yenisei or Obi; one by way of Franz-Josef Land, starting from the New Siberian Islands or the Lena; and one from a suitable spot in Bering Strait.

SOME CHINESE MORTUARY CUSTOMS.*

By ADELE M. FIELDE.

WHEN the Chinese wish to declare the extreme vexatiousness of any piece of work, they say, "It is more trouble than a funeral"; the obsequies of a parent being reckoned the most maddening affair in human experience.

Infants are buried summarily, without coffins, and the young are interred with few rites; but the funerals of the aged, of both sexes, are elaborate in proportion to the number of the descendants and to their wealth. When a childless married man dies, his widow may perform all the duties of a son toward him, may remain in his house, and may adopt children to rear as his heirs and as worshipers of the family manes. If his widow purposes marrying again, a young male relative may, with the consent of senior members of the clan, undertake the services expected from a son, and may inherit the estate of the deceased.

When one is about to die, he is removed from his couch to a bench or to a mat on the floor, because of a belief that he who dies in bed will carry the bedstead as a burden into the other world. He is washed in a new pot, in warm water in which a bundle of incense-sticks is merged. After the washing, the pot and the water are thrown away together. He is then arrayed in a full suit of new clothing, that he may appear in hades at his best. He breathes his last in the main room, before the largest door of the house, that the departing soul may easily find its way out into the air. A sheet of spirit-money, brown paper having a patch of gilding on one surface, is laid over the upturned face, because it is said that, if the eyes are left uncovered, the corpse may count the rows of tiles in the roof, and that in such case the family could never build a more spacious domicile.

The sons unbraid their queues, and by this dishevelment indicate the confusion of the household. They also take off their tunics, turn one half sidewise over the other half, and put them on again in such a way as to clothe only a moiety of the body. The left shoulder is made bare if it be the father, and the right shoulder if it be the mother, who has died. Thus the son shows that he is denuded of his usual protection, on the one hand or the other, the left ranking above the right in Chinese etiquette. If he be orphaned, he goes naked to the waist in any weather. He also girds himself with a wadded garment twisted into a rope. This cumbrous girdle expresses the fact that he has been obliged to

* The author writes from her own observations at Swatow, but does not mean to be understood as implying that all the customs described are general throughout the empire.—Editor.

hastily brace himself for the arduous labors that have come upon him through bereavement.

Messengers go to inform all the kindred of the demise, and an elderly man, of the same surname as the deceased, dressed in sackcloth and followed by the eldest son, takes a new earthen saucepan, goes to a running stream, throws three sheets of spirit-money upon it, and, dipping in the direction of the current, takes water with which to cleanse the corpse. A sprig of bamboo or of banyan is inserted in the snout of the saucepan, the bamboo with its straight, evenly jointed stem being the type of paternal rule, and the banyan, with its unfading verdure, being the symbol of maternal affection. While the son is gone to buy the water of purification, the relatives assemble in the house, and, when his return is announced by his moans, they burst out simultaneously into a loud wail, each naming the relationship of the deceased to himself. It is thought that the son may be comforted by this indirect reminder that his parent had many friends who share the grief of the nearest of kin. The corpse is sprinkled with the water shaken from a branch of pomegranate, the many-seeded emblem of increase, and it is then ready for encoffining. Two paper images, one of a man, the other of a maid-servant, are bought and placed beside the body. A son puts some boiled rice in the mouth of the corpse, saying, "You fed me while I grew, I feed you when you are dead," and then commands the two images to obey the behests of the departed and to run on all errands as directed by him. The images stand rigid before any number of prostrations made by the mourners, but are blown down by a breath of wind. They perhaps inspire the general feeling of superstitious aversion against being fanned by another, and originate the common polite inhibition, "I would receive a hundred obeisances from you sooner than one puff of air from your fan."

The male relatives then go in a body to the temple of the local tutelary deity, and announce the death. They carry lighted lanterns, because the daytime of men is the night of gods and spirits. The bell is tolled, the eldest son prostrates himself before the shrine as many times as will correctly indicate the years of the departed, and gives the sad information of his decease. They then return to the house of mourning, and some one goes to a soothsayer to ascertain what time will be lucky for the encoffining of the corpse. The natal dates, recorded for every member of the family, must be laid before the soothsayer, and some moment must be chosen whose signs are geomantically in accord with those of the birthdays and hours of the living, else evil will accrue to any whose horoscope conflicts. To lay the dead in the coffin without regard to the birth-times of those who assist would endanger life needlessly. Some propitious hour during the first, second, or third

day is usually discovered and fixed upon. This time having arrived, the clothes of the deceased, or new cloth cut into lengths sufficient for a tunic, are distributed among the assistants, are used as girdles while the body is lifted into the coffin, and are afterward kept by the wearers.

Thrifty, elderly persons have stanch coffins made for themselves while in good health. They are kept in a loft, receive a new coat of lacquer occasionally, and harden during perhaps a score of years for final use. If the coffin has not been previously prepared, a son buys one from a maker, who gives the buyer a couple of oranges or a package of confectionery, that the transfer of goods may not be an unmixed sadness to his customer. Some person, familiar with the route, must guide the bearers by the shortest road to the house of the purchaser, for an empty coffin imperils the welfare of the inmates of any dwelling to which it is taken, and a mistake in regard to its destination would bring rough treatment to those who carried it.

After the body is laid in the coffin, a piece of silver, real or counterfeit, is placed under the tongue. It is said that in ancient times the full value of a man's possessions was paid to him by his heirs at his demise, and was deposited with him in his coffin for burial. But later on, though long ago, a man who had foreknowledge, warned his children that there would be a rebellion in their day, and that a certain noble would rifle graves to get funds for the carrying out of his treasonable designs. When this man died, the prospective rebel was invited to assist in encoffining the corpse, and the sons put into the coffin only a small piece of silver, which they slipped under his tongue. Years passed, and the prophecy of the dead father was fulfilled; but, while other graves were opened, his remained undisturbed, because the rebel chieftain knew it contained no treasure. Since that time the practice of putting a bit of silver under the tongue has superseded the older custom of burying large sums of money with the corpse.

The evening after the encoffining a supper is spread for all the relatives of other surname than that of the deceased. Those of the same surname, reckoning themselves sinners, and therefore in sorrow, cook and serve the banquet.

As soon as the corpse is encoffined, a screen of white cloth is stretched across the main room just in front of the shelf on which sit the household gods, opposite the front entrance to the house. The coffin stands parallel with the screen, and close behind it, shut off from the view of those who pass the open door. In front of the screen, at its center, a chair is placed, holding an effigy of the deceased, and dressed in his clothing. This is called the seat of the spirit. Before the effigy a square table is set as an altar, and draped with a white cover and valance. A pair of large bou-

quets of white artificial flowers, stuck in balls of clay, are set upon the altar, and the worship of the dead then commences. Many female relatives stay behind the screen to wail. A child is appointed to watch and give notice of the approach of a worshiper, and at his signal the women wail in chorus. A male relative goes out, receives the guest, and kneels beside him while he bows and touches his forehead to the ground. The guest is then invited into another room to partake of tea, and the wailing ceases until another visitor arrives. Friends of various surnames and clans come during the first six days to pay obeisance to the dead, and bring bundles of spirit-money to be burned before the altar. The son of the recipient of these posthumous honors returns to each a present of a few feet of home-made white cloth, and invites all to the great performances of the seventh day.

The effigy and altar remain a hundred days, and before them the near relatives bow down and weep twice a day. Those who can wail in verse, eulogizing the departed, gain much approbation. Every morning and evening, so long as the coffin is in the house, or for one hundred days if the burial should be longer delayed, a daughter-in-law puts upon the altar a meal of vegetable food. The deceased is supposed to partake of its essence, and it is afterward added to the family mess. Beside the fare set forth for the dead man, there is laid upon the table a single chopstick and an egg for the jailer that has charge of the spirit until it is judged in hades. Having but half a pair of chopsticks to use, he must needs eat slowly, and so the dead man may get his share of the viands set forth!

Besides the occupations already described, the men of the afflicted family must procure food-stuffs, including pork, geese, and ducks, for the entertainment of guests; must hire mourning garments, or buy cloth for making them; must put an awning over the court in front of the house, to enlarge the space wherein the priests are to perform the ceremonies of the seventh day; and must order at the shops where outfits for ghosts are made all the paper paraphernalia which is to be burned at the funeral.

The women must, meanwhile, cook abundant meals for all who assist in the obsequies; must pound bushels of rice into flour for making steamed cakes to offer, with tea, to all comers; must make many little white bags, and put into each two long rolls of raw cotton, some green peas, some unhusked rice, and two copper coins, and must fasten these bags upon cords, whereby they can be tied around the waist. On the seventh day each son and son's wife wears three of these bags, all the children of the sons wear two bags, and each married daughter and son-in-law wears one bag. Mourning badges must also be made—wristlets of white for

all the sons, and wristlets of blue for all the grandsons. These are to be worn on the seventh day, and thereafter until they drop off through decay. The women must also make new red shoes for themselves, and cover them with sackcloth, and must make new mourning garments, or else sew shreds of white cotton along the seams and edges of their old tunics, to make them look like unfinished dresses that have been put on under the stress of sad circumstances.

On the seventh day after the demise, the deceased is supposed to become aware that he has departed this life, and on that day is performed the ceremony of accompanying him to the land of shades. Priests, Buddhist and Tauist, have been engaged for a fixed sum of money, with their entertainment, tobacco to smoke, tea to sip, and at least three substantial meals. Early in the morning the sons and daughters-in-law put on tunics of coarse sackcloth. The sons wear shoes patched with linen, a small or a large patch on the toe indicating whether one or both parents are dead. They put on a tall cap of sackcloth having a wad of spirit-money suspended on either side to dangle over the ears and shut out the criticisms of relatives who may be dissatisfied with their management of the funeral rites or with the quality of the repasts provided for the assisting mourners.

The Buddhist priests arrive and hang upon the white screen three pictures of Buddha, which are worshiped by the members of the bereaved family, especially by its women. Water is heated for the deceased to bathe in, and is put into a tub beside the coffin, and inclosed by a new mat. A paper towel and a complete suit of paper clothing are burned beside the coffin to furnish the spirit with suitable attire for the day's exercises. The Buddhist priests meanwhile chant an invitation to make use of the things provided. They continue to chant at intervals during the day, acting in concert with the Tauist priest, who takes the lead in conducting the spirit to hades. For one or three days and nights, according to the wealth and faith of the family, the priests continue their incantations, ringing bells, sprinkling the altar with holy water from a pomegranate-branch, and burning incense whose smoke fills the court. A plank is supported at its ends by two stools, and represents bridges. The Tauist priest, followed by the eldest son carrying an armful of copper coins, and by all the rest of the family in file carrying lighted incense-sticks, goes on a circuit through the house, court, or street, repeatedly crossing the mimic bridge. This is the exponent of the long journey made by the deceased across marshes, meadows, streams, and mountains toward the bourn from which no traveler returns. After many wearisome circuits, the priest stops and calls for the opening of the gate into hades. An assistant responds that the gate-keeper's fee

must first be paid, and the eldest son throws coins into the priest's bowl. After a turn or two more, the call is repeated, the invisible door is opened, and the spirit is supposed to pass in and to mount a lofty platform, from which it takes a final view of the house and village in which it has dwelt. The priests chant its valediction, saying:

> "On the last, highest lookout now I stand,
> And gaze toward home, with weeping loud and sore:
> Those who go farthest on an earthly strand
> May come again to kin and native land,
> But he who enters hell returns no more."

The mourners wail loudly, and the spirit is considered to have departed into the realm of shadows. The party led by the priest now take the short return journey, crossing the mimic bridge but once; for they say:

> "For going, ages scarce suffice;
> The coming back takes but a trice."

The priest then brings a miniature artificial lotus-garden, on whose terraces are images of the immortals, and sets it whirling on its standard over a basin of clean water. The mourners throw coins into the basin, to secure an abundance of pure water for the use of the deceased in the nether world. Various arts are used by the priest, at this and other stages of the performance, to increase the amount of cash thrown into his basin.

At nightfall the offerings which supply the dead with the necessaries of spirit-life are sent to him by burning them. Silver and gold coins, clothing of every sort and in many colors, opium and tobacco-pipes, spectacles, wallets, boxes, horses, sedan-chairs, boats, and servants, counterfeited skillfully in paper, and costing hundreds of dollars, are offered by the descendants and friends of the deceased, and are consumed in little bonfires that fill the court-yard with flame, smoke, and ashes. Married daughters bring armfuls of paper clothing and add it to the blaze, kneeling and leaning their heads against a bar from their looms. Neighbors and acquaintances bring packages of similar goods, and commit them, through the flames, to the care of the deceased, to be transferred by him to their own relatives in the region to which he is going. Some offer real articles, which are spread on tables, with edibles, and these are usually carried away during the night by poor souls still in the flesh. Supplies of paper goods are also burned for the poverty-stricken and friendless dead, who might without this pacification rob the beloved traveler of the things intended for his sole behoof. All night the fires glow, the smoke ascends, the priests chant, and the mourners wail.

On the morning of the eighth day the priests usually depart, and the family resumes, in some degree, its ordinary occupations. Three times, at the new and the full moon, the married daughters of the deceased each bring a pig's head and a large steamed cake, and join their brothers in worship before the seat of the spirit in their father's house. On the sixth day of the sixth Chinese month, after the removal of the seat of the spirit, the sons buy one cock, one water-melon, cakes, and incense, and offer them to their father's spirit, that being the day on which he, having been judged before ten courts in hades, crosses its narrow bridge and passes into a region decreed to him according to his deserts. The cock wakens him, and is afterward presented by him to the keeper of the bridge; the melon and cakes are distributed on the route, and the incense is burned in ceremonious respect to the deceased. After the first hundred days the dead parent receives offerings of food, with the burning of incense and spirit-money, about ten times a year, including always his birthday and the anniversary of his death

White is, in a general way, the color of mourning. Sons, during the first three days, wear the tunic wrong side out, and on one side of the body only. After that time they wear, like other mourners, garments of unbleached hempen cloth, except on the seventh day, when they and their wives wear sackcloth tunics, usually hired from a shop at which coffins are sold. The sons do not shave their heads for one hundred days, and they wear mourning for twenty-seven months, during which time they can not legally marry. Daughters and daughters-in-law put off mourning at the end of one year, when they resume their golden head-ornaments and don some bit of red.

The burial of the encoffined body is sometimes deferred for many years, awaiting the death of a spouse, or the favorable decision of a geomancer concerning a site for a tomb. As the prosperity of every man's descendants is thought to depend upon his being laid in a spot having such relationship to wind and water as will afford him undisturbed repose, the selection of a place of interment is sometimes difficult, and there are men who make their living by searching out good places for graves.

The grave being prepared, friends are informed of the burial, and they assemble at the appointed time to follow the coffin to the hills. The coffin is covered with a red pall. Two lanterns are tied together with a red cord, and arranged so as to hang one on either side of the coffin; and there may be as many pairs of lanterns as there are married couples among the descendants of the deceased. Small bags, with a red and a green side, are also hung upon the coffin, one for each member of the mourning household. The bags contain linen thread, cotton-rolls, peas, rice, hemp-seed, and coins,

emblems of longevity, fecundity, and wealth. They have an occult influence on the weal of the living.

Before the procession moves, twelve bowls of soup, in which pellets of dough float, are offered, with prostrations, to the dead. The number twelve and the vernacular name of the pellets express completeness, and are a funereal charade. Four or more men, hired for high wages, bear the coffin. It is followed to the grave by male friends, all in mourning, with tall white caps. The women, with white scarfs on their heads, go but a short distance from the house to a fork in the road, where a lad has been stationed with a banyan-branch. There they burn incense, make obeisance to the coffin, break off a twig of the banyan, and return by a route other than the one by which they came. A convenient superstition preserves them from a long journey on their maimed feet, and declares that they "must not follow the dead to death."

The sons of the deceased carry each a staff of bamboo or of banyan, which is left at the grave. Spirit-money is scattered along the road to buy right of way from demons that might oppose. The coffin being lowered, each person in the procession takes up some mortar in the flap of his tunic and casts it into the grave. When the pit is filled and rounded, *sesame*, whose vernacular name means completion, is planted on the top, to grow in sun and rain. A new, small gilded image, that has been brought with the coffin to the tomb, has a dot added to a hieroglyphic upon it, changing the meaning of the said hieroglyphic from *king* to *lord*. At this instant it becomes a household god, and is carried back with reverence to be placed on the shrine of the lares in the house, and worshiped with oblations.

During three years, on the anniversary of the death, presents of paper clothing are sent to the deceased by burning them. So long as there are male descendants living, they worship the grave in the seventh month of each year. When the family becomes so large that a division of the estate and separate dwellings are expedient, the images of the progenitors are inherited by the eldest son.

Mr. Balfour would make interest the ultimate criterion in the selection of reading for improvement. Knowledge is most easily attained in those subjects which we like most and take the most interest in. Our best course should be, having become interested in a subject, to read the best books upon it. By this rule we will read widely, and perhaps superficially; but thus reading, with freshness and vigor eager to be enlightened on this particular thing, will we not get more knowledge and be vastly more benefited than the man "who, with slow and painful steps, wearily plods through a list of books, though that list has in it all the masterpieces of creation"?

EYE-MINDEDNESS AND EAR-MINDEDNESS.*

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THE faculty that determines the direction of one's mental acquisitions has been termed "apperception"; it is equivalent to all that the mind brings with it *to perception.* Steinthal has made clear the nature and importance of this trait by a variety of clever illustrations. One of these relates to a party of German gentlemen who had traveled together all day, and as they were about to separate one of their number offered to tell the profession of each of the party if each would write without hesitation an answer to the question, "What destroys its own offspring?" One wrote, "Vital force." "You," said the questioner, "are a biologist." A second answered, "War," and was correctly pronounced a soldier. The philologist revealed his profession by writing "Kronos"; the publicist by writing "Revolution"; and the farmer by writing "She-bear." Each answered according to his apperceptive bent. The same thing is illustrated in Don Quixote's seeing a giant in a windmill; in our seeing a man in the moon; in the ancients finding curious animal shapes in the constellations; in children's and savages' personification of animals and natural phenomena; in Macbeth's vision of the dagger; or in the advice of that wise priest who told a maiden consulting him as to her acceptance of a certain suitor, to listen to the church-bells, and if she heard them saying, "*Take*-him, *take*-him," her happiness lay in acceptance, while if the bells rang out, "*Take*-him-*not*, *take*-him-*not*," no good could come of the union. The issue is left in doubt, but the maiden certainly followed her own mind. Especially when distinct perception is difficult does the subjective element of the process come to the front. In a country walk at night, an imaginative person constantly sees a ghost in what his more prosaic companion recognizes as a whitewashed tree. At a spiritualistic *séance,* it is well known that enthusiastic believers see whatever they are anxious to see. The general formula which sums up all these illustrations is, that we see with all that we have seen; we hear with all that we have heard; we learn with all that we have learned, and so on. Every acquisition and every action, however trivial, leaves a mark on our organization and becomes a causal link in the rest of our lives; it is in this way that experience leaves its deposit in character. This apperceptive

* The treatises dealing most fully and ably with the general subject of this article are G. Ballet's "Le langage intérieur et les diverses formes de l'aphasie," and V. Egger's "La parole intérieure"; see also S. Stricker's "Sprachvorstellungen," etc.

bent goes deep into human nature, and it is transmitted to our offspring; it reveals itself early in life, is a most valuable guide-mark to the educator, and plays a prominent *rôle* in the development of enthusiasm and of genius. It is one aspect of this important trait that is here to be treated—an aspect best described as "sensory apperception"—the part of our individual bent due to the relative intellectual importance of the several senses.

Man is a visual animal; as a race we are eye-minded. We regard "seeing as believing," and say we "see" when we comprehend. The language of every-day use, as well as the imagery of poetry, abounds in illustrations of the "pictorial" nature of thought. Primitive forms of "picture-writing" testify to the ease with which the eye takes the lead in expressing ideas; and modern civilization increases a hundred-fold this natural visual supremacy, which by some is regarded as originally due to the function of sight as a distance-sense ("anticipatory touch" of Spencer). The use of object-lessons, models, diagrams, the reduction of complex relations to the curves of the graphic system, and a host of similar devices,* all show how firmly the eye is the apprehensive organ of mankind, and how generally its educational value is appreciated. While, as a genus, we are eye-minded (in the same sense in which we might call a dog smell-minded), certain portions of the *genus homo* possess this faculty to a greater degree than others. Women visualize more distinctly than men; children think more vividly than adults; the French are (or were) noted for the skill with which they can foresee the effect of dress-combinations, festal decorations, and the like, and their phrase for "imagine" is "*figurez-vous.*" Similar individual variations have been well brought out by the studies of Mr. Francis Galton.† From the examination of a large number of answers to a long series of questions, he concluded that the brightness, vividness, and reality of the mental picture of a former experience varied in different persons from all absence of any pictorial element in the remembrance to a remembrance comparable to a colored photograph of the original scene. In describing their remembrance of the morning's breakfast-table, some saw it all bright, definite, and complete; the persons present, their costume, the dishes, the view—all stood out as in the actual scene. Another group could visualize only the main features; the picture lacked reality, omitted details, and was only fairly clear; while a third set could

* Perhaps the most striking device is that of teaching children the tones of the scale by association with colors (also with position of the hand, etc.); thus *do* would be red, *mi* yellow, etc. The association is explained (?) as due to a similar emotional effect of the sound and the color. I have heard a class of children sing from colors, and set up tunes in the same way.

† "Inquiries into Human Faculty," London, 1883.

hardly picture anything at all: they remembered the scene as they would a poem, but they saw nothing. Mr. Galton also finds that form is pictured better than color; that a high degree of visualizing power is apt to be hereditary; that scientific men as a class are poor visualizers, owing to their busying themselves with abstractions and generalizations, in which such a faculty would be inconvenient and thus fail to be cultivated; and many other interesting conclusions. When properly trained, and prevented from checking the plastic growth of mind, this faculty should be as useful an educational aid as the possession of a strong memory; like the latter, it is no mark of high intellectual capacity, but can be made a means of attaining it.

Some extreme and almost abnormal forms of this visualizing power are interesting in this connection. Examples of its extreme development are found in chess-players who play many games at once while blindfolded; in orators who "see" the pages of their manuscript as they speak; in mechanicians who picture every detail of construction and action of a machine in process of invention; in "lightning-calculators," who do their work on an imaginary blackboard; in artists painting a portrait or copying a painting from memory; and in countless others. Perhaps the crowning example is that of two chess-players, both gifted in this way, who could play a game of chess as they walked the streets; each announcing his move, and securely and readily picturing the result on their imaginary chess-board.

A strange development of this faculty (which, when it occurs, occurs almost always in conjunction with a strong visualizing power) is seen in certain imperative associations between colors or forms and sounds. The most common example is what Mr. Galton terms a "number-form." Many persons, when hearing or even thinking of a number or of a series of numbers, see these numbers arranged in definite shapes in a definite part of space. Some see them in the form of a circle; some as a broken line, the numbers 10, 12, 20, and 100 usually standing at the angles; and others have a variety of more complex and fantastic shapes. The letters of the alphabet—especially the vowels—the names of the months, of the days of the week, of persons and places, musical sounds, and so on, are associated in this realistic way with forms and colors. One gentleman has actually a whole alphabet of sound-colors, and can paint the sounds of *v-i-s-u-a-l-i-z-a-t-i-o-n* in colors, or read words out of wall-paper patterns.*

That such powers easily shade into the morbid is not hard to believe. Many of the chess-players who play blindfolded are

* Further examples and much interesting information are to be found in Mr. Galton's papers, *loc. cit.* (where are also illustrative diagrams and plates), and in "Zwangsempfindungen durch Licht und Schall," by Bleuler and Lehmann, 1881, a small monograph.

haunted by the chess-board at night. An artist painting an imaginary portrait saw the figure in his walks, saw it move, at length came to believe in its reality, and became insane. The creations of genius are sometimes similarly realized: Dickens walked the streets with "Little Nell" at his side. All such phenomena are likely to appear as visual; in dreaming, these are decidedly most frequent and prominent (in fact, we call a dream a "vision"); in hypnotism an imaginary visual sensation is easily induced; in incipient as in pronounced insanity, visual illusions and hallucinations are the most usual.

All these facts illustrate the leading *rôle* that vision plays in mental life—or, to speak physiologically, the high development of the cortical sight-center in man and its associative dominance over other cortical centers—as well as the great variety of its development in different individuals. Next to sight, the intellectually most valuable sense is hearing; that it owes much of this importance to its function as the medium of spoken language goes without saying. As in sight, so in hearing, the ease of perception and the clearness and accuracy of one's remembrance of musical or other sounds are subject to wide individual variations. Again, there are persons who possess this "auditizing" power to an unusual degree; to this class belong Mozart, who remembered the "Miserere" of the Sistine Chapel after two hearings; Beethoven, composing and silently repeating to himself whole symphonies after his deafness; "Blind Tom," performing any musical composition, however fantastic, after a single hearing, and so on. In ordinary experience, many persons reveal their dependence on auditory impressions by repeating things out loud to remember them, by closing their eyes and assuming the attitude of listening when trying to recall a word, and so on. Among the blind I have found many a good example of this type of mind, just as good visualizers are probably abundant among the deaf-mutes. A good illustration of the difference between what I shall term a "*visionaire*" and an "*auditaire*" is furnished by the conversation between the two dramatists, Legouvé and Scribe. "When I write up a scene," said Legouvé to Scribe, "I *hear* it; you *see* it; for every phrase I write, the voice of the character speaking it strikes my ear. You are the theatre itself; your actors walk and act under your eyes; I am of the *audience*, you of the *spectators*." "Nothing could be truer," said Scribe.

Instances in which certain forms or colors call up certain sounds are on record, though they occur much less frequently than the reverse. In one case the sight of the full moon looked at through a red glass has the sound of *l* joined to *o*. In dreams, hearing enters next frequently to sight (though in many cases the tactual-motor sensations predominate); in hypnotism an auditory

suggestion is very easily imposed; to the blind, hearing is decidedly the most valuable sense; and illusions and hallucinations of hearing are only slightly less frequent than those of sight. In general, the intellectual nature of these two senses presents a similar scale of individual differences, and suggests the action of like causes in their education as in their decay.

Third in importance is the group of muscular and tactual sensations accompanying motion. The importance of these is shown by the large factor of mere imitation in all training. The speaking of a language, though guided by the ear, and lost when hearing fails in childhood, is yet a separate acquisition, and deaf-mutes can be taught to speak by the muscular feelings alone. This avenue of knowledge was sufficient to bring to Laura Bridgman her phenomenal education. In common experience the value of this sense is illustrated by the tendency of many persons to speak to themselves, to move their lips when reading, to go through the motions of touching the keys of a piano when listening to a musical recitation. Many artists lay much stress on the teaching of free-hand movements apart from pencil and paper; singers often state that they "feel" an aria in their throats when they go over it to themselves; actors and athletes are, perhaps, likely to develop this kind of mental faculty, and among blind handicraftsmen it is frequent; while a certain school of psychologists define thinking as restrained action. The difficulty in estimating the importance of this sensory group to our intellectual fabric lies in the fact that it acts almost entirely under the guidance of the eye or of the ear; but analogy makes it probable that its importance varies much in different individuals. Such sensations enter into dreams, play a prominent *rôle* in hypnotism, where the assumption of an attitude will bring about the corresponding emotion, and have much to do in developing a common type of illusions and hallucinations. (Here belong the persecutions by crawling vermin, the feeling that the body is made of glass, or that the walls of the chest touch one another, and the like.)

Smell and taste need only a bare mention. The intellectual value of these senses reaches its climax in the lower animals.* Smell is a richly suggestive sense (witness the associations with the odor of funeral flowers, and the like), and taste gives us many emotional epithets, such as a "sweet" disposition. But our mentality has developed in other directions, and these senses have remained nearest to the conæsthesic stage.

Every normal-minded man uses each of the above avenues of knowledge in his mental processes, as well in acquiring as in retaining and digesting mental food. Certain acquisitions depend

* Perhaps the eccentric Dr. Jäger, who finds the seat of the soul in smell, is an unusual case of smell-mindedness—a highly developed "olfactaire."

almost exclusively upon the development of one intellectual center (music upon the auditory, painting upon the visual); and one in whom this center is poorly developed is deprived of all but mediocre achievement in that direction. But a far larger share of mental work is done by the combined use of various centers; and here, in what one does best by using the eye as the leading sense, another may succeed better by employing the ear as the teacher. The learning of one's mother-tongue is probably the best example of the operation in question. (A remark must be here inserted regarding the acquiring and the retaining of knowledge. It may be that one sense acquires knowledge readiest and another retains it best. But the utility of either process is so generally dependent upon the soundness of the other that we have good reason to believe that cases where different senses take charge of the two processes would be the exception. However, the question can only be settled by an experimental test. In general, the different sensory types will be supposed to refer to the combined process of memory and apperception, with the reservation, in necessary cases, of the possible difference just referred to.) In learning a language, one must first associate certain ideas with certain sounds, and again with the accompanying feelings of the vocal apparatus when making the sounds, and again with a certain set of visual symbols (usually more than one set—capitals, small letters, printed characters, script, etc.), and again with a set of muscular feelings when writing. And all this—the work of years—can be further complicated by the knowledge of several languages, of short-hand, and so on. In spite of this wonderfully complex and compact interassociation of the elements of language—as expressive of the intellectual utilization of sense-impressions—each sense keeps its store of images and its apperceptive grasp quite distinct. Pathology demonstrates that the distinctions here made are not abstractions, but have correlated with them separate physical substrata in the cells of various parts of the cortex; disease can paralyze any one of these cell-groups, shutting off one part of the language complex, and leaving all others quite intact. A few cases of this kind will bring out very clearly the distinctions in types of memory and apperception here treated. Dr. Charcot records the most striking case: A highly intelligent gentleman, well versed in several languages, was gifted with a remarkable visual memory. He could read pages of his favorite authors from the mental image of the printed page; he could sketch well from memory; and the mention of a scene in a play or of an incident of any of his many travels at once called up a bright and complete picture of the entire scene. He had, however, no fondness for music, and what he heard impressed him very little. As a consequence of business troubles, he became nervous and irritable.

With this his visual apperception and memory gave way. The scenes of his daily walks seemed strange; if asked to picture a certain spot, he was unable to do so; the attempt to draw a church-spire resulted in a rude, childish scrawl. Later on, the familiar scenes of his childhood faded from his memory; he could not picture the appearance of his wife and child, and even failed to recognize his own image in a mirror. In order to keep up his literary tastes, everything had to be *read out loud* to him; he had to cultivate his little-used auditory center. He now no longer dreamed of seeing, but of hearing. In short, without impairment of vision or of general intelligence, his excellent visualizing powers faded out, and he was left dependent upon his auditory center. By nature a strong "visionaire," disease forced him to become an "auditaire."

In sensory aphasia, cases occur in which the patient can not understand *spoken* words; he may be able to speak himself, can write, and has no defect of hearing. But the power to apperceive, to get the meaning out of sounds, is lost. The same may happen to the function of the *motor* sense in written language. In a typical case the patient suddenly lost all power to write; he had no paralysis, could read manuscript, could talk and hear. But the knowledge of the movements necessary to form the letters had dropped from his mind. If the disease progresses, he may lose the knowledge of all those little gestures and facial expressions that fill the gaps of social intercourse. In these cases—and more varieties could be added—we have clearly illustrated the distinctness of each of these sensory faculties, and of the various degrees of importance they assume in different minds.

It will doubtless have occurred to many a reader that this natural difference of faculty has a practical, an educational aspect. If each one can best absorb his mental food in a certain way, a knowledge of the nature of this peculiarity is certainly desirable. An absence of this knowledge is certain to bring about waste of energy, and especially so as these differences are already apparent in early youth, when a proper recognition of them can do something to remove the unnecessary friction of school-room methods. Dr. J. Mortimer-Granville has clearly grasped the practical aspect of this principle in his primer on "The Secret of a Good Memory." The leading note of that essay is the necessity of finding out the sensory bent of one's memory, and following out the clew thus gained. An eye-minded person should read, should reduce everything to visual terms; and it is because of the common occurrence of this trait that such mnemonic systems as associate everything with a certain spot on a general scheme have been successful. To an "auditaire" they would be worse than useless. The latter must have things read to him; will gain much

from conversation, and so on. Dr. Granville does not recognize the motor-type, but gives a series of tests for distinguishing between an eye-minded and an ear-minded person, which, in brief, are as follows: Unknown to the subject of the trial, a slip of paper containing some eight or ten monosyllabic words, arranged so as to have no natural association, is prepared and presented to him to be *silently read once only.* He must then write as many of the words as he can remember. The same is repeated with an equivalent set of words *read aloud once* to the subject, which he attempts to repeat. A comparison of the errors in a number of papers prepared in this way will reveal whether the words are better apprehended by the eye or by the ear. By having a longer or shorter interval between the reading and the repeating, the sense by which the subject *remembers* more securely will be determined.

The test is good but insufficient; a reliable and complete estimate of the part played in one's mental life by the several senses can be gained only by a series of varied and mutually corroborative tests. A few such tests which I have tried and found satisfactory—and which will readily suggest others—will be here detailed.

The general principles on which I proceed are three: I. I test the *limit* of the capacity for receiving impressions by the eye, and a similar limit for the ear. The sense that has the largest capacity is the dominant one. II. I test the subject in a performance in which error is sure to occur, both by eye and by ear, and compare the *amount* of the error in equally difficult performances, as well as derive hints from the *nature* of the errors. III. I have two processes, one requiring the use of the eye, the other that of the ear, going on *at the same time;* and find which one absorbs the maximum of attention and gets best remembered. All of these principles admit of a variety of applications, both for immediate apperception as well as for remembrance after an interval.

I. The simplest test relates to the mechanical apprehension of form and sound. For this one can find the maximum number of nonsense-syllables that can be repeated after a single reading, and compare it with the number remembered after a single hearing. One can do the same with numbers, with words of a foreign tongue, with simple diagrams or colors and sounds, and so on. The "visionaire" remembers more of the seen; the "auditaire" of the heard. The next step is to use significant words, as Dr. Granville suggests. It is still more instructive and often amusing to take short sentences from the newspaper or a book and find the largest number of words in construction retained after a single hearing or a single reading. Another interesting test is to find the num-

ber of repetitions necessary to commit a paragraph or a string of words too long to be retained after a single hearing or a single reading; here, as everywhere, care must be taken to have the paragraphs of equal difficulty, and to repeat the test a number of times. Dr. Ebbinghaus * has made a valuable study of the memory, tracing a curve of forgetfulness, and establishing many interesting conclusions by this method; while Mr. Joseph Jacobs † and others have used the maximum number of sounds repeatable after a single hearing, which they call the "span," as a test of the growth of mental power with the increase of years, and as a mark of the narrow intellect of idiots. The successive corrections and improvements, until a perfect repetition is possible, are often full of interest. The "auditaire" reaches this stage sooner by having the passage, etc., read, the "visionaire" by reading it; in addition I find that the former has all along (both in I, II, and III) a tendency to remember the *last* words best, while the latter retains the *first* most readily. One must also observe by which method the sense is best retained when the exact words are forgotten; moreover, it may be noted that the one confuses words allied in sound, the other words are in appearance, and so on.

II. All the various processes described under I can be repeated with the list of words, numerals, paragraphs, and the rest, so long that error is sure to arise. It is not necessary to give details. These errors are often highly amusing as well as instructive. The fleetness with which an impression which you feel perfectly sure of firmly possessing while listening or reading, suddenly disappears with a blank in its place, is very startling. After an interval, only the most prominent words or ideas are left. Of three persons subjected to a variety of tests, one retained most and more of what the eye had taken in, the second nearly equally of each, with a preponderance of the visual, while the third (myself) was a decided "auditaire." This suggests the remark that a type of mind to which all the avenues of perception are almost equally attractive is doubtless common. In fact, M. Binet,‡ who has much interesting matter to offer on this topic, regards this indifferent type as the normal type, representing a harmonious development of all the sensory faculties. But here, as elsewhere, specialization has its advantages; and, moreover, if the tests are carefully made, I suspect a noticeable superiority in favor of sight will be the most usual result. It is not impossible to imagine the tests so arranged as to give roughly quantitative estimates of the relative impor-

* Hermann Ebbinghaus, "Ueber das Gedächtniss," Leipsic, 1885. An excellent monograph.

† "Mind," January, 1887; an article by Mr. Jacobs *et alii* and another by Messrs. Galton and Bain.

‡ Alfred Binet, "La Psychologie du Raisonnement," Paris, 1886.

tance of the several senses in this respect, and thus register the *degree* to which one is a "visionaire," "auditaire," and so on.

III. These form the most difficult as well as most interesting tests. Two paragraphs (of course, the same can be done with syllables, numerals, words, and so on), of equal difficulty are chosen, and, while one is *read by* the subject, the other is *read aloud to* him. The reading must not be especially loud or pronounced, but neither must it be monotonous. It is very important that, in repeating as much as possible of the contents of both paragraphs, one should as often repeat *first* what has been read as what has been heard. The amount of forgetting of the other paragraph that goes on while you repeat what you can of the one, is surprising. In this performance, appealing simultaneously to eye and ear, the "auditaire" is attracted to what he hears, the "visionaire" to what he sees, and the former knows more of what has been read, the latter of what he has read. A strong "visionaire" may, at times, know nothing of the passage read to him, while the "auditaire" may listlessly let his eye wander across the page, his attention being involuntarily chained to what he hears.

A modified form of this test can be adopted by finding the *limit* of words, etc., that can be perfectly learned by the eye and ear simultaneously. While the "auditaire" can listen to and retain six words, he may be able to read and retain (at the same time) only two or three words; while with the "visionaire" the propositions will be reversed. That it is possible to do these two things at once is shown by some ingenious experiments of M. Paulhan.* This observer finds that the more disparate the faculties used in doing two things at once, the better can they be done; and that the simpler the processes, the less the difference between the sum of the times necessary to do each separately and the time to do both at once, this difference failing entirely in very simple processes. When the two sentences get confused it is suggestive to note whether a heard word creeps into the passage read, or *vice versa.*

If a person is an "auditaire," a further test of the degree of this trait can be thus made: While a passage is being read to him, let him copy a sentence or two from a book. If a strong "auditaire," he will find that he has been writing automatically, knows little of what he has written, and can tell more or less of what he has heard. The "visionaire," on the other hand, knows what he has written almost word for word, and less than usual of what has been read to him. That is, with a strong "auditaire," hearing outweighs sight even when supported by the muscular sense; while, when thus supported, sight more than usually outweighs hearing for the "visionaire."

* "Revue Scientifique," June, 1887; reported in "Science," July 8, 1887.

A few words should be said about those to whom action is the chief aspect of mental experience—the "motaires." I have not succeeded in devising a satisfactory test for the importance of this avenue of knowledge in our mental fabric, for the obvious reason that it operates so generally under the guidance of the eye or (in speaking) of the ear. (It would be easier to devise tests applicable to the congenitally blind.) Even when we write or draw with closed eyes, we imagine and interpret what we do by how it will look. A few hints as to the strength of this faculty can be gathered from some of the above and similar experiments. In the last test, for example, he who would be decidedly aided by writing what he read would be somewhat strongly motor-minded; while this trait would be weak in one not much aided by writing what he reads. Again, one might find the limit of memory for words, sentences, etc., written from a copy and again written from dictation, and observe which the motor feelings aided more and how much altogether; one can also have the hand moved by another, drawing a more or less complicated figure, and compare the attempt to repeat the drawing with a similar repetition of a drawing momentarily seen. These tests—for which the average of a large number of trials is necessary as a standard—would be certain to bring out decided "motaires," but they must be perfected before they are as available and conclusive as those for ear- and eye-mindedness.

It goes without saying that every one will probably have a hint (though often only a slight one) as to the sensory bent of his apperceptive processes, especially any one engaged in mental labor. If he is a "visionaire" he will have noted how much better he remembers what he reads than what he hears; that he often remembers the position of a word on a page; will, perhaps, have a good memory for forms and faces; will find that he can easily read while talking is going on; that he readily gets absorbed when his eye is occupied; and so on in a hundred ways. The "auditaire" will note that a lecture impresses him more deeply than a review article; that he imagines the sounds of the words as he reads or writes (and is usually thus a slow reader); that he repeats aloud what he has written to judge of its effect—he wants to know how "it sounds" even when it is only to be read; he observes harsh sound-combinations in style (the "visionaire" observes misprints); talking easily disturbs him when reading or writing, his attention being involuntarily drawn to the conversation; he may have a good memory for tunes, and so on. Those who approach the motor or the indifferent type will have greater difficulty in discerning this by hap-hazard observation. The above are, of course, only general descriptions; they will be variously modified in individual cases, but will retain a typical ap-

pearance throughout. Enough has been said to indicate the diversity of various minds in these respects, and the importance of recognizing and studying these distinctions, alike for their educational utilization and as a contribution to a scientific psychology.

ANTAGONISM.*

By Sir WILLIAM R. GROVE, F. R. S.

SOME months ago, shortly after I had resigned my office of Judge of the High Court, I was expressing to a friend my fear of the effect of having no compulsory occupation, when he said, by way of consolation, "Never mind, 'for Satan finds some mischief still for idle hands to do.'" You may possibly in the course of this evening think he was right. I have chosen a title for my lecture which may not fully convey to your minds the scope of the views which I am going to submit to you. I propose to adduce some arguments to show that "antagonism," a word generally used to signify something disagreeable, pervades all things; that it is not the baneful thing which many consider it; that it produces at least quite as much good as evil; but that, whatever be its effect, my theory—call it, if you will, speculation—is that it is a necessity of existence, and of the organism of the universe so far as we understand it; that motion and life can not go on without it; that it is not a mere casual adjunct of Nature, but that without it there would be no Nature, at all events as we conceive it; that it is inevitably associated with unorganized matter, with organized matter, and with sentient beings.

I am not aware that this view, in the breadth in which I suggest it, has been advanced before. Probably no idea is new in all respects in the present period of the world's history. It has been said by a desponding pessimist that "there is nothing new, and nothing true, and nothing signifies," but I do not entirely agree with him; I believe that in what I am about to submit there is something new and true in the point of view from which I regard the matter; whether it signifies or not is for you to judge. The universality of antagonism has not received the attention it seems to me to deserve from the fact of the element of force, or rather of the conquering force, being mainly attended to, and too little note taken of the element of resistance unless the latter vanquishes the force, and then it becomes, popularly speaking, the force, and the former force the resistance.

There are propositions applying more or less to what I am going to say of some antiquity. Heraclitus, quoted by Prof. Huxley,

* Lecture delivered at the Royal Institution of Great Britain, on April 20, 1888.

said, "War is the father and king of all things." Hobbes said war is the natural state of man, but his expressions have about them some little ambiguity. In Chapter I of the "De Corpore Politico," he says, "Irresistible might in a state of Nature is right," and "The estate of man in this natural liberty is war." Subsequently he says, "A man gives up his natural right, for when divers men having right not only to all things else, but to one another's persons, if they use the same there ariseth thereby invasion on the one part and resistance on the other, which is war, and therefore *contrary to the law of Nature, the sum whereof consisteth in making peace.*" I can only explain this apparent inconsistency by supposing he meant "law of Nature" to be something different from "the natural estate of man," and that the making peace was the first effort at contract, or the beginning of law; but then why call it the "*law of Nature,*" where he says might is right? There is, however, some obscurity in the passage. The Persian divinities, Ormuzd and Ahriman, were the supposed rulers or representatives of good and evil, always at war, and causing the continuous struggle between human beings animated respectively by these two principles. Undoubtedly good and evil are antagonistic, but antagonism, as I view it, is as necessary to good as to evil, as necessary to Ormuzd as to Ahriman. Zoroaster's religion of a divine being, one and indivisible, but with two sides, is, to my mind, a more philosophical conception. The views of Lamarck on the modification of organic beings by effort, and the establishment of the doctrine of Darwin as to the effects produced by the struggle for existence and domination, come much nearer to my subject. Darwin has shown how these struggles have modified the forms and habits of organized beings, and tended to increased differentiation, and Prof. Huxley and Herbert Spencer have powerfully promoted and expanded these doctrines. To the latter we owe the happy phrase, "survival of the fittest"; and Prof. Huxley has recently, in a paper in the "Nineteenth Century," anticipated some points I should have adverted to as to the social struggles for existence. To be anticipated, and by a very short period, is always trying, but it is more trying when what you intended to say has been said by your predecessor in more terse and appropriate language than you have at your command.

I propose to deal with "antagonism" inductively—i. e., with facts derived from observation alone—and not to meddle with spiritual matters or with consequences. Let us begin with what we know of the visible universe, viz., suns, planets, comets, meteorites, and their effects. These are all pulling at each other, and resisting that pull by the action of other forces. Any change in this pulling force produces a change, or, as it is called, perturbation, in the motion of the body pulled. The planet Neptune, as

you know, was discovered by the effect of its pulling force on another planet, the latter being deflected from its normal course. When this pulling force is not counterbalanced by other forces, or when the objects pulled have not sufficient resisting power, they fall into each other. Thus, this earth is daily causing a bombardment of itself by drawing smaller bodies—meteorites—to it; twenty millions of which, visible to the naked eye, fall on an average into our atmosphere in each twenty-four hours, and of those visible through the telescope, four hundred millions are computed to fall within the same period. Mr. Lockyer has recently given reasons for supposing the luminosity of nebulæ, or of many of them, is due to collisions or friction among the meteorites which go to form them; but his paper on the subject is not yet published.

What is commonly called centrifugal force does not come from nothing; it depends upon the law that a body falling by the influence of attraction, not upon, but near to, the attracting body, whirls round the latter, describing one of the curves known as conic sections. Hence, a meteorite may become a planet or satellite (one was supposed to have become so to this earth, but I believe the observations have not been verified); or it may go off in a parabola as comets do; or, again, this centrifugal force may be generated by the gradual accretion of nebulous matter into solid masses falling near to, or being thrown off from, the central nucleus, the two forces, centrifugal and centripetal, being antagonistic to each other, and the relative movements being continuous, but probably not perpetual. Our solar system is also kept in its place by the antagonism of the surrounding bodies of the cosmos pulling at us. Suppose half of the stars we see—i. e., all on one side of a meridian line—were removed, what would become of our solar system? It would drift away to the side where attraction still existed, and there would be a wreck of matter and a crash of worlds. It is very little known that Shakespeare was acquainted with this pulling force. He says, by the mouth of Cressida—

> "But the strong base and building of my love
> Is as the very center of the earth
> Drawing all things to it"—

a very accurate description of the law of gravitation, so far as this earth is concerned, and written nearly a century before Newton's time.

But in all probability the collisions of meteorites with the earth and other suns and planets are not the only collisions in space. I know of no better theory to account for the phenomena of temporary stars, such as that which appeared in 1866, than that they result from the collision of non-luminous stars, or stars previously invisible to us. That star burst suddenly into light, and

then the luminosity gradually faded, the star became more and more dim, and ultimately disappeared. The spectrum of it showed that the light was compound, and had probably emanated from two different sources. It was probably of a very high temperature. If this theory of temporary stars be admitted, we get a nebula of vapor or star-dust again, and so may get fresh instances of the nebular hypothesis.

Let us now take the earth itself. It varies in temperature, and consequently the particles at or near its surface are in continuous movement, rubbing against each other, being oxidized or deoxidized, either immediately or through the medium of vegetation. This also is continuously tearing up its surface and changing its character. Evaporation and condensation, producing rain, hail, and storms, notably change it. Force and resistance are constantly at play. The sea erodes rocks and rubs them into sand. The sea quits them and leaves traces of its former presence by the fossil marine shells found now at high altitudes. Rocks crumble down and break other rocks, or are broken by them; avalanches are not uncommon. The interior of the earth seems to be in a perpetual state of commotion, though only recurrent to our observation. Earthquakes in various places from time to time, and, doubtless, many beneath the sea of which we are not cognizant, nor of other gradual upheavals and depressions. Throughout it nothing that we know of is at rest, and nothing can move without changing the position of something else, and this is antagonism. Metals rust at its surface, and probably they or their oxides, chlorides, etc., are in a continuous state of change in the interior. Nothing that we know of is stationary. The earth as a whole seems so at first sight, but its surface is moving at the rate of some seventeen miles a minute at the equator; and standing at either of the poles—an experiment which no one has yet had an opportunity of trying—a man would be turned round his own axis once in every twenty-four hours, while the earth's motion round the sun carries us through space more than a million and a half of miles a day. The above changes produce motion in other things. The earth pulls the sun and planets, and in different degrees at different portions of its orbit.

Before I pass from inorganic to organized matter, I had better deal with what may perhaps strike you as the most difficult part of my subject, viz., light. Where, you may say, is there antagonism in the case of light? Light exercises its force upon such minute portions of matter that until the period of the discovery of photography its physical and chemical effects were almost unknown. Such effects as bleaching, uniting some gases, and affecting the coloring-matter of vegetables, were partly known but little attended to; but photography created a new era: I shall advert

to this presently. The theories of light, however, involved matter and motion. The corpuscular theory, as you well know, supposed that excessively small particles were emitted from luminous bodies, and traveled with enormous velocity. The undulatory theory, which supplanted it, supposed that luminous bodies caused undulations or vibrations in a highly tenuous matter called ether, which is supposed to exist throughout the interplanetary spaces and throughout the universe so far as we know it. Some suppose this ether to be of a specific character, differing from that of ordinary gases, others that it is in the nature of a highly attenuated gas; but, whatever it be, it can not be affected by undulations or vibrations without being moved, and when matter is moved by any force it must offer resistance to that force, and hence we get antagonism between force and resistance. Light also takes time in overcoming this resistance, i. e., in pushing aside the ether. It travels no doubt at a good pace—about one hundred and ninety thousand miles in a second; but even at this rate, and without being particular as to a few millions of miles, it takes three years and a quarter to reach us from the star which, so far as we know, is the nearest to us, viz., α Centauri. The ether, or whatever it may be called, tenuous as it is, is not unimportant, though it be not heavy. Without it we should have no light and possibly no heat, and the consequences of its absence would be rather formidable. I believe you have heard Dr. Tyndall on this subject. Supposing the visible universe to be as it is now supposed to be, i. e., in no part a mere vacuum, there can be no force without resistance in any part of it.

But photography carries us further, it shows us that light acts on matter chemically, that it is capable of decomposing or forcing asunder the constituents of chemical compounds, and is therefore a force met by resistance. In the year 1856 I made some experiments, published in the "Philosophical Magazine" for January, 1857, which seemed to me to carry still further what I may call the molecular fight between light and chemical affinity, and among them the following: Letters cut out of paper are placed between two polished squares of glass with tin-foil on the outsides. It is then electrized like a Leyden jar, for a few seconds, the glasses separated, the letters blown off, and the inside of one of the glasses covered with photographic collodion. This is then exposed to diffuse daylight, and on being immersed in the nitrate of silver bath the part which had been covered with the paper comes out dark, the remainder of the plate being unaffected. (This result was shown by the electric-light lantern.) In this case we see that another imponderable force, electricity, invisibly affects the surface of glass in such a way that it conveys to another substance of definite thickness, viz., the prepared collodion, a change in the

chemical relations of the substance (iodide of silver) pervading it, enabling it to resist that decomposition by light which, but for some unseen modification of the surface of the glass plate, it would have undergone; and no doubt the force of light, being unable to effect its object, was reflected or dispersed, and instead of changing its mode of motion in effecting chemical decomposition, it goes off on other business. The visible effect is in the collodion film alone. I have stripped that off, and the imprint remains on it, the surface of the glass being, so far as I could ascertain, unaffected. Thus, in the film over the protected part, light conquers chemical affinity; in that over the non-protected part, chemical affinity resists and conquers light, which has to make an ignominious retreat. It is a curious chapter in the history of the struggles of molecular forces, and probably similar contests between light and chemical or physical attractions go on in many natural phenomena, some forms of blight and some healthy vegetable changes being probably dependent on the varying effects of light and conditions, electrical or otherwise, of the atmosphere.

Let us now pass on to organic life. A blade of grass, as Burke, I believe, said as a figure of speech, is fighting with its neighbors. It is robbing them, and they are trying to rob it—no agreement or contract, simply force opposed to force. This struggle is good for the grass; if it got too much nutriment it would become diseased. The struggle keeps it in health. The rising of sap in trees, the assimilation of carbon, the process of growth, the strengthening themselves to resist prevalent winds, and many other instances might be given, which afford examples of the internal and external struggles in vegetable life.

I will now proceed to consider animal life, and in this case I will begin with the internal life of animals, which is a continual struggle. That great pump, the heart, is continuously beating—that is, conquering resistance. It is forcing the blood through the arteries, they assisting in squeezing it onward. If they give way, the animal dies; if they become rigid and resist too much, the animal dies. There must be a regulated antagonism, a rhythmical pulsation, the very term involving force and resistance. That the act of breathing is antagonistic scarcely needs argument. The muscular action by which the ribs are made to open out and close alternately, in order to inhale and exhale air, and other physiological changes which I can not here go into, necessitate a continuous fight for life. So with digestion, assimilation, and other functions, mechanical and chemical forces and resistances come into play. Since this lecture was written, I have heard of a discovery made, I am informed, by Prof. Metschnikoff, and which has brought to light a singular instance of internal antagonism. He is said to have proved that the white corpuscles

of the blood are permanent enemies of bacteria, and by inoculation will absorb poisonous germs; a recurrent war, as it appears, going on between them. If the corpuscle is the conqueror, the bacteria are swallowed up and the patient lives. If the corpuscles are vanquished, the patient dies and the bacteria live, at all events for a time. If the theory is founded, it affords a strong additional argument to the doctrine of internal antagonism. Possibly, if there were no bacteria, and the corpuscles had nothing to do, it would be worse for them and the animal whom they serve.

Let us now consider the external life of animals. I will take as an instance, for a reason which you will soon see, the life of a wild rabbit. It is throughout its life, except when asleep (of which more presently), using exertion, cropping grass, at war with vegetables, etc. If it gets a luxurious pasture, it dies of repletion. If it gets too little, it dies of inanition. To keep itself healthy it must exert itself for its food; this, and perhaps the avoiding its enemies, gives it exercise and care, brings all its organs into use, and thus it acquires its most perfect form of life. I have witnessed this effect myself, and that is the reason why I choose the rabbit as an example. An estate in Somersetshire, which I once took temporarily, was on the slope of the Mendip Hills. The rabbits on one part of it, viz., that on the hill-side, were in perfect condition, not too fat nor too thin, sleek, active, and vigorous, and yielding to their antagonists, myself and family, excellent food. Those in the valley, where the pasturage was rich and luxuriant, were all diseased, most of them unfit for human food, and many lying dead on the fields. They had not to struggle for life, their short life was miserable, and their death early; they wanted the sweet uses of adversity—that is, of antagonism. The same story may be told of other animals. Carnivora, beasts or birds of prey, live on weaker animals; weaker animals herd together to resist, or, by better chance of warning, to escape, beasts of prey; while they, the herbivora, in their turn are destroying vegetable organisms.

I now come to the most delicate part of my subject, viz., man (I include women, of course!). Is man exempt from this continual struggle? It is needless to say that war is antagonism. Is not peace so also, though in a different form? It is a commonplace remark to say that the idle man is worn out by *ennui*, i. e., by internal antagonism. Kingsley's "Do-as-you-like" race—who were fed by a substance dropping from trees, who did no work, and who gradually degenerated until they became inferior to apes, and ultimately died out from having nothing to do, nothing to struggle with—is a caricature illustrative of the matter. That the worry of competition is nearly equivalent to the hardships and perils of military life seems proved to me by the readiness with which mili-

tary life is voluntarily undertaken, ill as it is paid. If it were well paid, half our men would be in the military or naval service, and I am not sure that we should not have regiments of Amazons! The increased risk of life or limbs and the arduous nature of the work do not prevent men belonging to all classes from entering these services, little remunerative as they are. Others take the risks of traveling in the deserts of Africa or wintering in the polar regions, of being eaten by lions or frozen to death, of falling from a Swiss mountain or foundering in a yacht, in preference to a life of tranquillity ; and sportsmen elect the danger of endeavoring to kill an animal that can and may kill them, to shooting tame pheasants at a *battue* or partridges in a turnip-field. Then, in what is euphemistically called a life of peace, buyer and seller, master and servant, landlord and tenant, debtor and creditor, are all in a state of simmering antagonism; and the inventions and so-called improvements of applied science and art do not lessen it. Exercise is antagonism ; at each step force is used to lift up our bodies and push back the earth ; as the eminent Joseph Montgolfier said, that when he saw a company dancing, he mentally inverted his view and imagined the earth dancing on the dancers' feet, which it most unquestionably did. Indeed, his great invention of balloons was guessed at by his witnessing a mild form of antagonism between heat and gravitation. He, being a dutiful husband, was airing his wife's dresses, who was going to a ball. He observed the hot air from the fire inflated the light materials, which rose up in a sort of spheroidal form (you may have some of you noticed this form in dress!). This gave him the idea of the fire-balloon, which, being a large paper-maker at Annonay, he forthwith experimented on, and hence we got aërial navigation. This anecdote was told me by his nephew M. Seguin, also an eminent man. Even what we call a natural death is a greater struggle than that which other animals go through, and is, in fact, the most artificial of all deaths. The lower animals, practically speaking, do experience a natural death, i. e., a violent or unforeseen death. As soon as their powers decline to such an extent that they can not take part in the struggle for existence, they die or are killed, generally quickly, and their sufferings are not protracted by the artificial tortures arising from the endeavors to prolong life.

Let us now pass from individuals to communities. Is there less antagonism now than of yore? Do the nations of Europe now form a happy family? Are the armaments of Continental nations, or is the navy of this country, less than in former years? The very expression "the great powers" involves antagonism. As with wars and revolutions, so, as I have said, with regard to individuals, during our so-called peace, the fight is continuous among communities. If the water does not boil, it simmers. Not

merely are there the struggles of poor against rich going on, but the battles for position and pre-eminence are constant. The subjugated party or sect seeks first for toleration, then for equalization, and then for domination. We call contentment a virtue, but we inculcate discontent. A father reproaches his son for not exerting himself to improve his position, and at school and college and in subsequent periods of life efforts at advancement in the social scale are recommended. Individual antagonisms, class antagonisms, political, trading, and religious antagonisms take the place of war. Can war exhibit a more vigorous and persistent antagonism than competition does? Take the college student with ruined health; take the bankrupt tradesman with ruined family; take the aspirants to fashion turning night into day, and preferring gas or electric light to that of the sun. But our very amusements are of a combative character: chess, whist, billiards, racing, cricket, foot-ball, etc. And in all these we, in common parlance, speak of *beating* our opponent. Even dancing is probably a relic and reminiscence of war, and some of its forms are of a military character. I can call to mind only one game which is not combative, and that is the game you are in some sort now playing, viz., "patience," and with, I fear, some degree of internal antagonism!

Take, again, the ordinary incidents of a day's life in London. Fifteen to twenty thousand cabs, omnibuses, vans, private carriages, etc., all struggling, the horses pushing the earth back and themselves forward, the pedestrians doing the same, but the horses compulsorily—they have not as yet got votes. The occupants of the cabs, vans, etc., are supposed to act from free will, but in the majority of cases they are as much driven as the horses. Insolvents trying to renew bills, rich men trying to save what they have got by saving half an hour of time. Imagine, if you can, the friction of all this, and add the bargaining in shops, the mental efforts in counting-houses, banks, etc., and road-repair, now a permanent and continuous institution. Take our railways: similar efforts and resistances. Drivers, signal-men, porters, etc., and the force emanating from the sun millions of years ago, and locked up in the coal-fields, as Stephenson suggested, now employed to overcome the inertia of trains and to make them push the earth in this or that direction, and themselves along its surface. Take the daily struggles in commerce, law, professions, and legislation, and sometimes even in science and literature. Politics I can not enter upon here, but must leave you to judge whether there is not some degree of antagonism in this pursuit. In all this there is plenty of useful antagonism, plenty of useless—much to please Ormuzd and much to delight Ahriman; but of the two extremes, overwork or stagnation, the latter would, I think, do Ahriman's work more

efficiently than the former. We cry peace when there is no peace. Would the world, however, be better if it were otherwise? Is the Nirvana a pleasing prospect? Sleep, though not without its troubles and internal antagonism, is our nearest approach to it, but we should hardly wish to be always asleep.

Shakespeare not only knew something about gravitation, but he also knew something about antagonism. He says, by the mouth of Agamemnon:

> "Sith every action that hath gone before
> Whereof we have record, trial did draw
> Bias and thwart, not answering the aim,
> And that unbodied figure of the thought
> That gav't surmised shape."

In no case is the friction of life shown more than in the performance of "duty," i. e., an act of self-resistance, a word very commonly used; but the realization of it is by no means so frequent. Indeed, faith in its performance so yields to skepticism that it is said that, when a man talks of doing his duty, he is meditating some knavish trick.

The words good and evil are correlative: they are like height and depth, parent and offspring. You can not, as far as I can see, conceive the existence of the one without involving the conception of the other. In their common acceptation they represent the antagonism between what is agreeable or beneficial and what is painful or injurious. An old anecdote will give us the notion of good and evil in a slenderly educated mind. A missionary having considered that he had successfully inculcated good principles in the mind of a previously untutored savage, produced him for exhibition before a select audience, and began his catechism by asking him the nature of good and evil. "Evil," the pupil answered, "is when other man takes my wife." "Right," said the missionary, "now give me an example of good." The answer was, "Good is when me takes other man's wife." The answer was not exactly what was expected, but was not far in disaccord with modern views among ourselves and other so-called civilized races. I don't mean as to running away with other men's wives! But we still view good and evil very much as affecting our own interests. At the commencement of a war each of the opposing parties view victory—i. e., the destruction of their enemies—as good, and being vanquished as evil. Congregations pray for this. Statesmen invoke the god of battles. Those among you who are old enough will call to mind the Crimean War. Each combatant nation gives thanks for the destruction of the enemy, each side possibly believing that they respectively are in the right, but in reality not troubling themselves much about that minor question. We (un-

consciously perhaps) "compound for sins we are inclined to by damning those we have no mind to." So in the daily life of what is called peace. The stage-coach proprietor rejoiced when he had driven his rival off the road, railway directors and shareholders now do the same, so do publicans, shopkeepers, and other rivals. We are still permeated by the old notion of good and evil. But "antagonism," as I view it, not only comprehends the relation of good and evil, but, as I have said, produces both, and is as necessary to good as to evil. Without it there would be neither good nor evil. Judging of the lives of our progenitors from what we see of the present races of men of less cerebral development, we may characterize them as having been more impulsive than ourselves, and as having their joys and sorrows more quickly alternated. After the hunt for food, accompanied by privation and suffering, comes the feast to gorging. Their main evil was starvation, their good repletion. Even now the Esquimau watches a seal-hole in the bitter cold for hours and days, and his compensation is the spearing and eating the seal. The good is resultant upon and in the long run I suppose equivalent to the evil. These men look not back into the past, and forward into the future, as we do. We, by extending our thought over a wider area, are led to more continuing sacrifices, and aim at more lasting enjoyment in the result. The child suffers at school in order that his future life may be more prosperous. The man spends the best part of his life in arduous toil, physical or mental, in order that he may not want in his later years, or that his family may reap the benefit of his labor. Further-seeing men spend their whole lives on work little remunerative that succeeding generations may be benefited. The prudent man transmits health and wealth to his descendants, the improvident man poverty or gout. One main element of what we call civilization is the capability of looking further back into the past, and further forward into the future; but, though measured on a different scale, the average antagonism and approximate equivalence appear to me to be the same.

Can we suppose a state of things either in the inorganic or the organic world which, consistently with our experience or any deduction drawn from it, would be without antagonism. In the inorganic world it would be the absence of all movement, or, what practically amounts to the same thing, movement of everything in the same direction, and the same relative velocity; for, as movement is only known to us by relation, movement where nothing is stationary or moving in a different direction, or with a different velocity, would be unrecognizable. So in the organic but nonsentient world, if there were no struggle, no absorption of food, no growth, nothing to overcome, there would be nothing to call life. If, again, in the sentient world there were no appetites, no hopes

—for both these involve discontent—no fear, no good or bad, what would life be? If fully carried out, is not a life without antagonism no life at all, a barren metaphysical conception of existence, or rather alleged conception, for we can not present to the mind the form of such conception? In the most ordinary actions, such as are necessary to sustain existence, we find, as I have already pointed out, a struggle more or less intense, but we also find a reciprocal interdependence of effort and result. The graminivorous animal is, during his waking hours, always at work, always making a small but continuous effort, selecting his pastures, cropping vegetables, avoiding enemies, etc. The carnivora suffer more in their normal existence; their hunger is greater, and their physical exertion, when they are driven by hunger to make efforts to obtain food, is more violent than with the herbivora if they capture their prey by speed or battle, or their mental efforts are greater if they capture it by craft. But then their gratification is also more intense, and thus there is a sort of rough equation between their pain and their pleasure: the more sustained the labor, the more permanent is the gratification. As with food or exercise, deficiency is as injurious in one as is excess in another direction; so, as affecting the mind of communities, as I have stated it to be with individuals, the effect of a life of ease and too much repose is as much to be avoided as a life of unremitting toil. The Pitcairn-Islanders, who managed in some way to adapt their wants to their supply and to avoid undue increase of population, are said never to have reached old age. In consequence of the uneventful, unexcited lives they led, they died of inaction, not from deficiency of food or shelter, but of excitement. They should have migrated to England! They died as hares do when their ears are stuffed with cotton, i. e., from want of anxiety. We have hope in our suffering, and in the mid-gush of our pleasures something bitter surges up:

> "We look before and after, and pine for what is not,
> Our sincerest laughter with some pain is fraught,
> Our sweetest songs are those which tell of saddest thought."

The question may possibly occur to you, Have we more or less antagonism now than in former times? We certainly have more complexity, more differentiation, in our mental characteristics, and probably in our physical, so far as the structure of the brain is concerned; but is there less antagonism? With greater complexity come increased wants, more continuous cares. Higher cerebral development is accompanied with greater nervous irritability, with greater social intricacies—we have more frequent petty annoyances, and they affect us more. With all our so-called social improvements, is there not the same struggle between crime

and its repression? If we have no longer highway robberies, how many more cases of fraud exist, most of it not touched by our criminal laws! As to litigation, I am perhaps not an impartial judge, but it seems to me that, if law were as cheap as it is desired, every next-door neighbor would be in litigation. It would seem as if social order had never more than the turn of the scale which is necessary to social existence in its favor when contrasted with the disorganizing forces. Without that there would be perpetual insurrections and anarchy. But though antagonism takes a different form, it is still there. Are wars more regulated by justice than of yore? I venture to doubt it, though probably many may disagree with me. National self-interest or self-aggrandizement is, I think, the predominant factor, and is frequently admittedly so. I also doubt if the old maxim, "If you wish for peace, prepare for war," is of much value. Large armaments and improvements in the means of destruction (whose inventors are more thought of than the discoverers of natural truths) are as frequently the cause of war as of its prevention. Are wars less sanguinary with 100-ton guns than with bows and arrows? I can not enter into statistics on this subject, but a sensible writer who has, viz., Mr. Finlaison, came to the conclusion that wars cease now as anciently, not in the ratio of the improvements in killing implements, but from exhaustion of men or means. Wars undoubtedly occur at more distant intervals, or the human race would become extinct. Probably the largely increased competition supplies their place: we fight commercially more and militarily less. It is a sad reflection that man is almost the only animal that fights, not for food or means of life or of perpetuating its race, but from motives of the merest vanity, ambition, or passion. War is, however, not wholly evil. It develops noble qualities—courage, endurance, self-sacrifice, friendship, etc.—and tends to get rid of the silly incumbrances of fashion and ostentation. But do the much-bepraised inventions of peace bring less antagonism? Consider the enormous labor and waste of time due to competition in the advertising system alone. Paper-making, type-founding, printing, pasting, posting or otherwise circulating, sandwich-men, etc., all at work for purposes which I venture to think are in great part useless; and those who might add to the productiveness of the earth, or to the enriching our knowledge, are helping to extend the limits of the black country, and wasting their time in interested self-laudation. And the consumer pays the costs. "Buy my clothing, which will never wear out." "Become a shareholder in our company, which will pay cent per cent." "Take my pills, which will cure all diseases," etc. These eulogies come from those highly impartial persons the advertisers, all promising golden rewards, but, as with the alchemists, on condition that gold be paid in ad-

vance for their wares; and the silly portion of the public, no small body, take them at their word. Though you may not fully agree in this my anathema of the advertising system, and though there may be some small modicum of good in it, I think you will agree that it affords a notable illustration of antagonism. If I were a younger man, I think I should go to Kamchatka to avoid the penny post; possibly I should not be satisfied when I got there. Civilization begins by supplying wants, and ends by creating them; and each supply for the newly created want begets other wants, and so on, "*toties quoties.*"

As far as we can judge by its present progress, mankind seems tending to an automatic state. The requirements of each day are becoming so numerous as to occupy the greater portion of that day; and when telegrams, telephones, electro-motion, and numerous other innovations which will probably follow these, reach their full development, no time will be left for thought, repose, or any spontaneous individual action. In this mechanical state of existence, in times of peace, extremes of joy and sorrow, of good and evil, will become more rare, and the necessary uniformity of life will reduce passion and feeling to a continuous petty friction. The converse of the existence contemplated by the Stoics will be attained, and, instead of a life of calm contemplation, our successors will have a life of objectless activity. The end will be swallowed up in the means. It will be all pursuit and no attainment. Is there a *juste milieu*, a point at which the superfluous *commoda vitæ* will cease? None probably would agree at where that point should be fixed, and the future alone can show whether the human race will emancipate itself from being, like Frankenstein, the slave of the monster it has created. In the cases I have given as illustrations—and many more might be adduced—the evil resulting from apparently beneficial changes is not a mere accident: it is as necessary a consequence as reaction is a consequence of action. In the struggle for existence or supremacy, inevitable in all social growths, the invention, enactment, etc., intended to remedy an assumed evil, will be taken advantage of by those for whom it is not intended; the real grievance will be exaggerated by those having an interest in trading on it, and the remedy itself will have collateral results not contemplated by those who introduce the change. I could give many instances of this by my own experience as an advocate and judge, but this would lead me away from my subject. Evils, indeed, result from the very change of habit induced by the alleged improvement. The carriage which saves fatigue induces listlessness, and tends to prevent healthy exercise. The knife and fork save the labor of mastication, but by their use there is not the same stimulus to the salivary glands, not the full healthy amount of secretion, whereby digestion suf-

fers; there is not the same exercise of the teeth whereby they are strengthened and uniformly worn, as we see in ancient skulls. It seems not improbable that their premature decay in civilized nations is due to the want of their normal exercise by the substitution of the knife and fork and stew-pan. According to the evolution theory, our organs have grown into what they are, or ought to be, by long use, and the remission of this tends to irregular development, or atrophy. Every artificial appliance renders nugatory some pre-existing mode of action, either voluntary or involuntary; and as the parts of the whole organism have become correlated, each part being modified by the functions and actions of the others, every part suffers more or less when the mode of action of any one part is changed. So with the social structure, the same correlation of its constituent parts is a necessary consequence of its growth, and the change of one part affects the well-being of other parts. All change, to be healthy, must be extremely slow, the defect struggling with the remedy through countless but infinitesimally minute gradations.

Lastly, do the forms of government give us any firm ground to rest upon as to there being less undue antagonism in one than in another form? Whether it is better to run a risk of, say, one chance in a thousand or more of being decapitated unjustly by a despot, or to have what one may eat or drink, or whom one may marry, decided by a majority of parish voters, is a question on which opinions may differ, but there is abundant antagonism in either case. Communism, the dream of enthusiasts, offers little prospect of ease. It involves an unstable equilibrium, i. e., it consists of a chain of connection where a defect in one link can destroy the working of the whole system, and why the executive in that system should be more perfect than in others I never have been able to see. Antagonism, on the other hand, tends to stability. Each man working for his own interests helps to supply the wants of others, thus ministering to public convenience and order, and if one or more fail the general weal is not imperiled.

You may ask, Why this universal antagonism? My answer is, I don't know; science deals only with the how, not with the why. Why does matter gravitate to other matter with a force inversely as the square of the distance? Why does oxygen unite with hydrogen? All that I can say is, that antagonism is to my mind universal, and will, I believe, some day be considered as much a law as the law of gravitation. If matter is, as we believe, everywhere, even in the interplanetary spaces, and if it attracts and moves other matter, which it apparently must do, there must be friction or antagonism of some kind. So with organized beings, Nature only recognizes the right, or rather the power, of the

strongest. If twenty men be wrecked on a secluded island which will only support ten, which ten have a right to the produce of the island? Nature gives no voice, and the strongest take it. You may further ask me, *Cui bono?* what is the use of this disquisition? I should answer, If the views be true, it is always useful to know the truth. The greatest discoveries have appeared useless at the time. Kepler's discovery of the relations of the planetary movements appeared of no use at the time; no one would now pronounce it useless. I can, however, see much probable utility in the doctrine I have advocated. The conviction of the necessity of antagonism, and that without it there would be no light, heat, electricity, or life, may teach us (assuming free will) to measure effort by the probable result and to estimate the degree of probability. It may teach us not to waste our powers on fruitless objects, but to utilize and regulate this necessity of existence; for, if my views are correct, too much or too little is bad, and a due proportion is good (like many other useful things, it is best in moderation), to accept it rather as a boon than a bane, and to know that we can not do good without effort—that is, without some suffering.

I have spoken of antagonism as pervading the universe. Is there, you may ask, any limit in point of time or space to force? If there be so, there must be a limit to antagonism. It is said that heat tends to dissipate itself, and all things necessarily to acquire a uniform temperature. This would in time tend practically, though not absolutely, to the annihilation of force and to universal death; but if there be evidence of this in our solar system and what we know of some parts of the universe, which probably is but little, is there no conceivable means of reaction or regeneration of active heat? There is some evidence of a probable zero of temperature for gases as we know them, i. e., a temperature so low that at it matter could not exist in a gaseous form; but passing over gases and liquids, if matter becomes solid by loss of heat, such solid matter would coalesce, masses would be formed, these would gravitate to each other and come into collision. It would be the nebular hypothesis over again. Condensation and collisions would again generate heat; and so on *ad infinitum.*

Collisions in the visible universe are probably more frequent than is usually supposed. New nebulæ appear where there were none before, as recently in the constellation of Andromeda. Mr. Lockyer, as I have said, considers that they are constant in the nebulæ; and if there be such a number of meteorites as are stated to fall daily into the atmosphere of this insignificant planet, what numbers must there be in the universe? There must be a sort of fog of meteorites, and this may account, coupled with possibly some dissipation of light or change of it into other forces, for the smaller

degree of light than would be expected if the universe of stellar bodies were infinite. For if so, and the stars are assumed to be of an equal average brightness, then if no loss or obstruction, as light decreases as the square of the distance and stars increase in the same ratio, the night would be as brightly illuminated as the day. We are told that there are stars of different ages—nascent, adolescent, mature, decaying, and dying; and when some of them, like nations at war, are broken up by collision into fragments or resolved into vapor, the particles fight as individuals do, and, like them, end by coalescing and forming new suns and planets. As the comparatively few people who die in London to-night do not affect us here, so in the visible universe one sun or planet in a billion or more may die every century and not be missed, while another is being slowly born out of a nebula. Thus worlds may be regenerated by antagonism without having for the time more effect upon the Cosmos than the people now dying in London have upon us. I do not venture to say that these collisions are in themselves sufficient to renew solar life; time may give us more information. There may be other modes of regeneration or renewed activity of the dissipated force, and some of a molecular character. The conversion of heat into atomic force has been suggested by Mr. Crookes. I give no opinion on that, but I humbly venture to doubt the mortality of the universe.

Again, is the universe limited? and if so, by what? Not, I presume, by a stone wall! or, if so, where does the wall end? Is space limited, and how? If space be unlimited and the universe of suns, planets, etc., limited, then the visible universe becomes a luminous speck in an infinity of dark, vacuous space, and the gases, or at all events the so-called ether, unless limited in elasticity, would expand into this vacuum—a limited quantity of ether into an infinite vacuum! If the universe of matter be unlimited in space, then the cooling down may be unlimited in time. But these are perhaps fruitless speculations. We can not comprehend infinity, neither can we conceive a limitation to it. I must once more quote Shakespeare, and say in his words, "It is past the infinite of thought." But whatever be the case with some stars and planets, I can not bring myself to believe in a dead universe surrounded by a dark ocean of frozen ether. Most of you have read "Wonderland," and may recollect that after the Duchess has uttered some ponderous and enigmatical apothegms, Alice says, "Oh!" "Ah," says the Duchess, "I could say a good deal more if I chose." So could I; but my relentless antagonist opposite (the clock) warns me, and I will only add one more word, which you will be glad to hear, and that word is—Finis.—*Nature.*

MENTAL TRAITS IN THE POULTRY-YARD.

By BENJAMIN KARR.

THE instincts and ordinary habits of the common barn-yard fowl have been closely studied and exhaustively discussed, but it is otherwise with the almost human emotions and mental processes which are sometimes to be observed in the poultry-yard. The mere searcher for knowledge will discover them with difficulty, but they are easily found by an eye which sees with the long familiarity of companionship. Many summers of fond intimacy with the poultry of a western New York farm long ago convinced at least two boys of this fact. Living in Buffalo, the writer and a brother, who was an inseparable companion, boarded through the whole or a part of several seasons, sometimes six months together, on a farm in Orleans County. Our time was entirely our own, and, as we found little companionship among the busy country lads, many days might have hung heavily on our hands had we not been wholly content to spend the greater part of them among the chickens and the turkeys; only one season, we added ducks. Our parents had taught us to love and observe Nature, and we were well read for our years in natural history. What was of more importance, we had been led from early childhood to be exact and painstaking in all things. Our play with toys was tiresome to most boys by reason of its carefulness. Under such circumstances it will not, perhaps, be thought strange that either of us could tell every fowl, young or old, toward the end of each summer, by its name and nearly all of them by their cackling. Usually there were about one hundred on the premises. We not only knew their general appearance as we would familiar faces, but I think there is no doubt that a glimpse of even the half of any head in the barn-yard would have been enough for instant recognition. We knew every hen's nest, when the egg-yield was two dozen a day, and my brother could promptly and with certainty sort out ten dozen eggs and tell which hen laid every one. When there were twenty half-grown cockerels on the farm we could readily name any one which crowed out of sight. Poultry, hens as well as their more pugnacious lords, always keep a well-defined scale of authority in force. Not one out of fifty is ignorant of its superiors and inferiors. A brood of young chickens will often settle all this business, while yet little more than fuzzy balls, by a series of really cruel fights. We never missed these exhibitions of infantile ferocity if we could help it, and a particularly savage young fighter was immediately a marked object of our admiring interest. He was usually given

a long name out of the copious vocabulary of our chicken dialect, a form of speech which always amazed those who chanced to overhear it. We counted it one of the least of our duties to keep accurately informed concerning all changes of rank, and to know at any time just how many others every fowl on the farm could "boss," and how many, in turn, "bossed" it. From the old sultan, who acknowledged no rivals, to the forlorn "scrub" of the youngest brood of chicks which had fought out their station, there were no exceptions. These facts, which might easily be multiplied, will suffice to account for the exceptional observations of our long experience as poultry-lovers.

We early learned that our pets had striking individuality. In this broad fact we found ample reason to note with interest rather than surprise the after-discoveries of almost human traits which made them a never-ending delight. There were young roosters all fuss and bluster from the first, while others were singularly quiet and wary, just as some hens were solitary and suspicious, and others were trustful in the extreme and wretched without much company. These traits were not only inherited, but could be discerned very early. Two or three of the bravest hens on the farm would always, after "stealing a nest," with our permission, bring out a brood of young fighters as much like their mother in habits as in appearance. We could only guess at the descent in the male line. In one case of this kind, where a fine hen was left with but a single chick after the casualties of the first few days, we managed to make the little fellow so conceited and pugnacious that he would fight chickens twice his size, and more than once before he was weaned he tried to whip his mother. This we did by throwing food to a larger chicken, beginning with one which we knew to be cowardly, in such a way that it would get the morsel while its tail was turned toward our little champion. Immediately another tidbit, dropped in front of the victim, would make it appear to be running away at the very time that it was getting all the food the other wanted. He soon showed his disgust by pecking the retreating form of the hungry chicken, and we never let the object of his wrath turn until he was very sure that it was afraid of him; then, if it showed too much pluck, we could always tempt or drive it away in time to make our little pet think it was really conquered. The tiny victor was as proud as if he had been four times as big, and got his fill to eat as his reward. By a long course of this sort of training his audacity became only less remarkable than his courage and fierceness in fighting. With other young roosters, until they were nearly half-grown, the same tactics usually succeeded in bringing on a fight. Often we started a "feed" with one, the confident master, and the other, the uneasy but intimidated subject, and ended it with the

positions reversed, after a bloody struggle. In this test the difference in disposition was exactly what it would have been in human beings under like conditions. Some were eager to venture a peck at the apparently yielding tyrant, and would quickly jump at the conclusion that he was overthrown. But the confidence with which a cockerel of this sort chased his indignant but hungry master was only exceeded by the briefness of his resistance when the outraged victim of our tricks was allowed to turn and fight. Young roosters of another stamp could only rarely be deceived into mistaking the movements of a superior in rank, but when, after long and careful manœuvring, in which the one of us whose business it was to keep away a swarm of hungry spectators generally grew very tired, the subject did conclude that he had somehow changed places with his former tyrant, there was a fierce fight, and the rebel often won. It was the old story of the terrors of pugnacity, hard to arouse, and the strength of purposes slowly formed.

It is in fighting that some of the most curious traits are manifested by fowls of all kinds. Notice the coops of Cochins and brahmas in a poultry-show, and you will find many of the cocks with combs bloody and scarred from pecking one another's heads. They thrust their necks out between the side of the coop and the first slat in front and clumsily punish each other. In long rows of coops of games, placed in exactly the same way, not a peck is given. It is not that the slow and easily whipped Asiatics are fonder of fighting than the ideal gladiators of the animal world, but simply that no game-cock will put himself at a disadvantage by getting his head in reach first. When game-cocks look out, it is through one of the middle spaces. Fighting is too serious a business with these high-spirited birds to be mixed with foolishness. Other breeds than games, however, occasionally produce natural fighters that show remarkable cunning. A light and graceful young dominique, one of the proudest and most intelligent of our pets, belonged to a neighbor, but was very fond of coming over to a barn-yard which was about as near his home as the house where we boarded. He was very reluctant to endure punishment in fights, but he was also loath to retreat before any antagonist, and dearly loved to have us feed him and "bide and doctor wi' 'im," as the Devonshire farm-hand put it. The consequence was, that he would try a round with any foe, and if he found himself overmatched he generally managed to retreat with a brave show of fight and get off without much loss of blood or prestige. One day he was attacked by a turkey, and at the very beginning of the combat he happened to light on its back. No descendant of the race which lived, in a wild state, in terror of the downward swoop of the great horned owl, can bear to be attacked from

above, and the turkey cried for quarter at once. The lesson of the easy victory was not lost, and thenceforth the young cock fought turkeys with evident relish, always managing to reach their backs, and so routing them with ease and celerity. Our best rooster, however, was too strong and heavy to suit him, and encounters with this hard fighter were very unwelcome. While one of us fed the visitor, the other would catch the home champion, and by taking him around to the farther side of the barn let him enter the barn-yard on the trespasser's line of retreat. Of course, there would be a fight, and it was difficult for the jaunty intruder to make his escape in good order without many severe knocks. After a time he always kept a sharp watch on the dangerous corner of the barn-yard, and at any suspicious noise in that quarter he started for home in great excitement. At last he almost entirely ceased to visit us. In the cellar of a house in Buffalo, where a number of chickens and two or three turkeys which had been brought up from a farm on Grand Island were kept until wanted for the table, I once saw a young black Spanish cock fight and win a bloody battle with a very large gobbler. The turkey tried to escape his vindictive conqueror by taking refuge upon a board partition at least four feet high, between two empty coal-bins. There he stood and stretched his long neck out as far as possible. The victor flew up beside him and tried in vain to reach his head. Then he wasted a few savage pecks upon the gobbler's heavy wing, and gave that up in disgust. At last he appeared to study out a plan, and deliberately flew straight for the turkey's head, seized it with his beak, and hung on as long as possible. Then, dropping to the ground, he contentedly mounted again to the side of his terrified victim and repeated the punishment. This he did the third time, with perfect system, and would have gone on indefinitely had I not interfered to save the wretched bird. An Indian could not have taken more delight in torturing a vanquished foe. The most remarkable exhibition of cunning in cock-fights, however, that came under my observation, was witnessed in the barn-yard of a farm adjoining our Orleans County headquarters. There were three old roosters on the place, and they had divided up the territory instead of holding each one a certain rank in all of it. The cow-stable and a corner of the barn-yard adjacent belonged to a big clumsy partridge Cochin, the horse-stable and the grain-barn to a cock more black Spanish than anything else, and the end of the barn-yard farthest from the stables, with the house door-yard, to a white Leghorn. There were neutral zones, as the diplomats say, between every two divisions, and these were the scene of some sharp fighting and a great deal of crowing and hostile manœuvring. One day the Cochin and the white Leghorn met in the barn-yard, and

the latter began his usual tactics of worrying his enemy, taking precious care of himself all the time. He was never fond of hard hitting, but trusted mainly to trickery. The big Cochin would stretch his neck up, now and then, and thunder out a ponderous challenge, and every time the agile Leghorn made a quick rush, sometimes going six feet, and knocked the helpless Asiatic nearly or quite off his feet before he could stop crowing or lower his head. When the victim recovered, his foe was invariably out of reach. At last the white rooster was given a taste of his own clever tactics. He had been crowing freely with impunity all the time, but suddenly, as he began another shrill taunt, he was startled by a rush like his own and knocked over before he could get into position for defense. After that the Cochin never missed a chance to use this artifice in fighting, with other cocks as well as the white Leghorn. He had acquired skill as truly as any general ever did.

An amusing test of the difference of disposition in barn-yard fowls may be made by placing a piece of looking-glass against the trunk of a large tree, and laying a train of corn in front of it. Some hens will discover what they all take for a new arrival with mild curiosity and merely look at it intently, perhaps peering around behind the tree, and then walk quietly away. Others peck the glass angrily and insist upon fighting, while a few nervous females show much the same noisy excitement that seizes upon most hens when they spy a snake. We tried the valiant old autocrat of the farm-yard with this trick, and he was at once roused to fury. Dropping his head when some ten feet in front of the glass, he began the cautious advance by parallels, which every one familiar with poultry has seen before a fight. But, of course, he soon lost his enemy by moving too far to one side. After crowing fiercely and looking around uneasily for a few moments, he returned to the train of corn, and almost instantly saw the strange cock nearer than before. More stealthy approach, another failure to keep sight of the foe, and greater excitement, and a third time he began to eat, only to be startled by the hostile presence nearer than ever. At last he worked right up to the glass and braced himself for the shock of combat, the counterfeit, of course, following his every movement with ominous celerity. There was one fierce peck at the angry head in the glass, and then a crash, as our infuriated champion hurled himself against his likeness, breaking the glass into a hundred fragments. The mingling of astonishment, rage, and triumph in this bird's appearance, as he whirled about, startled at the cracking noise, and bewildered by the total disappearance of his enemy, was comical to behold. Then he rushed around behind the big pear-tree, evidently thinking that the cowardly stranger might be

hidden there. Not finding him, the victor strutted about, too excited to eat, and crowed long and loud over his unprecedented triumph. The other cock was entirely wiped out of existence, and our old fighter, who would crow defiantly in our arms whenever he found himself being carried off the premises, knowing from experience that a set-to was coming, could scarcely credit his senses.

Of the many feelings which human beings and poultry have in common, one is the sense of mortification. On a fine summer morning a group of cockerels, of various ages, were lounging about in the door-yard, when they began a crowing tournament. Some of the smallest and most humble stood contentedly on the ground, but soon one flew upon the carriage-step and crowed from that elevation. He was promptly eclipsed by another, who gave vent to an exultant challenge from the top of the hitching-post. Then the proudest and handsomest of them all walked a few steps with an air of conscious superiority, and flew straight up to the highest bar of the reel of a reaper near by. It was a simple reel of light horizontal bars, not connected with the rake, and revolved very easily. While the young dandy's wings were still flapping in triumph and he had not yet begun to crow, the reel turned under his weight and lowered him swiftly to the ground. Without a sound the crestfallen rooster walked away, too ashamed to look around. We often enjoyed a still more amusing exhibition of this sort on the part of the proudest old cock on the place. He was a very gallant Mormon, and intensely self-conscious when among the hens; but if coaxed off by himself, on a side of the house where no other fowl was in sight, he could be easily frightened out of his dignity. A hat thrown at him would send him squawking around the corner of the building, his plumage disarranged, and his whole appearance eloquent of blind terror. We always managed it that he should run straight into a group of hens, and the desperate haste with which he choked down his wild cackling and began to murmur amorous nothings to the ladies of his harem was only less ridiculous than the instant change in his whole appearance, which became that of a pompous and leisurely sultan. He generally overacted a little, making an extra display of his careless gallantry and elegance to show how absurd it was to suspect that he could have been in the least alarmed. A laughable instance of similar mortification in the biggest turkey on the farm was noticed one late autumn day, when this great gobbler and numerous others, much younger and smaller, were eating grass and strutting in the door-yard. Just as the old gobbler spread his tail for a tremendous strut, a young turkey stepped quickly up behind him and pecked sharply at the small spot of skin exposed in the center of the big fellow's

great fan of feathers. It was evidently done through a mistaken notion of the object tested, but it hurt the victim's pride terribly to have such liberty taken with his person. Down came his tail, and he walked off in injured dignity, conscious that he had been involved in something ridiculous.

A disappointed barn-yard fowl is often as cross as if it could show its temper after the manner of human beings. The big dominique rooster that smashed the looking-glass was a very good-natured fellow with hens and young chickens, and he seldom resented having kernels of corn, no matter how many, snatched out from under his beak, when it was done in a fair scramble. But if he had begun to crow, and a kernel was unexpectedly dropped where he certainly would have got it, had he not been so busy, it was too much to see his share taken away by any other fowl. He frequently pecked the offender as soon as he could stop crowing, and showed general ill-temper for a few moments. His indignation was so amusing, that we fell into the habit of teasing him in this way, until, at last, the old fellow began to practice choking down the rest of his crow when corn was thrown in front of him. Gradually he managed to stop more and more quickly, and in the end he would swallow his voice with a gulp, and snatch a bit of food as promptly as if he had not been crowing at all.

A half-brother of this rooster learned very quickly to crow for corn, once for every kernel. He used to stand before us and crow as regularly as clock-work, always stopping for his reward, and never expecting a second kernel until he had crowed again. When almost satisfied, he waited much longer between times, and at last walked contentedly away. A black hen once showed almost equal intelligence in learning, not how to get food but how to be relieved of some which she could not help carrying around on her feathers. In the barbarous eagerness of boys to bring about fights, we often daubed old hens that held high rank and had many discontented subjects, with mud or anything else which would disguise them. On one occasion we dyed a speckled cock red with carpet-dye, glued a stiff, high comb of paper on his frost-amputated stump, and tied up his wattles under his throat. This overdid the business to such an extent that the other roosters fled from him in horror, as if he had been a hawk, and the Devonshire farm-hand, looking at him in amazement, exclaimed, "Byes, what fresh bird have ye brought about here?" Mud failed on the black hen in question, and we tried common paste, never thinking of one result—it turned the poor hen's feathers back, like those of a frizzled fowl—and, after we had done our best to wash the paste off, she was still in a sad plight. Many of her inferiors whipped her badly, and at last she became broken in

spirit and made no resistance. Then the other hens began to eat the paste off her feathers, and the poor bird would deliberately walk up to her former subjects and stand patiently to be eaten clean. In time she recovered her beauty, but never her lost rank.

Nations, shorn of their prestige or territory in one quarter, often "seek compensation" in another, where their neighbors are weak; and brutes in human form, after being whipped in a drunken fight by other men, sometimes soothe their wounded pride by beating their wives at home. So it is with poultry. A cock, chased by one of higher rank, will often vent his spite upon the first half-grown cockerel that comes within his reach, and even bully hens around until he recovers from his own humiliation. From that allied weakness which makes men bluster most when in greatest fear, hens that are weak enough at other times, are savage toward young roosters, sure soon to become their masters. They chase them with noisy fury, and try in every way to intimidate them, carefully avoiding a trial of strength, however, as long as possible. When it comes, they collapse into shrieking submission, with laughable suddenness. When a hen simply ignores a young cockerel, he usually encounters much more serious resistance, and sometimes has to fight hard for victory.

Hens are harder to deceive, in some respects, than many women. They flock up to a rooster with eager freedom, when he is eating busily in silence, while they are very shy of heeding his most artful invitations to a feast, real or imaginary. When he eats they know there is something good, and that he is not thinking of entrapping them; but when he shakes his head up and down, picking up morsels in his beak and calling as a hen calls her chickens, they understand the amorous and deceitful ways of their lord too well to approach him rashly. Some cocks play comparatively few tricks, and they are much more trusted than others which are as insincere as seductive. Neither is the average fowl easily humbugged, on the other hand, by attempts to conceal a real feast. It is amusing to observe the calm, careless manner of a hen which has caught a mouse, as she walks off toward a secluded spot, making the same contented, nothing-to-do noise which is her ordinary note of idleness. This, of course, happens only when there is a chance that no other hen saw the mouse caught. But usually some quick-witted sister will at once "smell a mouse," and steal quietly up behind, not infrequently announcing her coming by snatching at the coveted dainty. The poultry-yard is always on the alert for a valuable discovery on the part of one of its inmates, and ready to put a sort of highway-robber socialism into practice at a moment's notice.

The foregoing plain statements of fact are but a few of the many proofs which the writer has seen of the existence in com-

mon barn-yard fowls of a degree of intelligence usually attributed only to much higher animals. Surely they show something far above the instincts familiar to all students of Nature. The sense of mortification in an individual has only a distant relationship to the rare instinct which makes chickens that were never out of the heart of a great city, and could not possibly have seen a more formidable bird than a pigeon, skurry for shelter when the far-off cry of the common hen-hawk is imitated in their presence. It is impossible for the bare narration of anecdotes to convey that certainty of intelligence and human emotions which early gave my brother and myself a sense of nearness to our farm-yard pets. We saw the countless little tricks of manner, the changes of expression, the indefinable consciousness which can never be appreciated save by those who, like ourselves, will literally live among unconfined and well-treated poultry. The purpose of this tribute will be served if it shall raise the reputation for intelligence of the barn-yard fowl, not indeed to the level of our belief, but somewhat above that on which the reader has heretofore placed it. The lesson is the oft-enforced truth that the greater part of what has been held by the majority of mankind to be exclusively human belongs only in less degree to the lower animals as well.

UNDERGROUND WATERS AND MINERAL VEINS.

By Prof. G. A. DAUBRÉE.

BEFORE occupying himself with the great masses that constitute the crust of the earth, and yielding to cupidity rather than to scientific curiosity, man attempted to discover the genesis of certain minerals. Have the middle ages not seen more than one alchemist, in his passionate search for the philosopher's stone, trying to discover the secret of Nature, and reproduce the processes by which she has created in the rocks gold, the most noble, as they said in those days, of the metals, and certainly the most precious?

According to the system of Thales, adopted by Aristotle, water was the universal principle of things. "If the elements are born of one another," wrote Seneca, "why may not the earth be produced from water? Like the human body, the earth includes a number of humors, some of which hardened when they came to maturity; whence the metallic earths, and stony substances, which are nothing but petrified liquids."

The hypotheses relative to the nature of mineral substances which were current down to the last century are related to this doctrine. Bernard Palissy, one of the most penetrative minds of his time, wrote: "All mineral matters that you call dead bodies

were also created as well as vegetable substances, and have been in travail to produce seeds from which others could be engendered. Crystal is not so dead but that it is given to it to know how to separate itself from other waters, and from itself, with its angles and diamond-points, in the midst of them. Thus, mineral matters are not so inert but they bring forth and gradually produce most excellent things. These mineral matters are intermingled and unrecognized among the waters, in the matrix of the earth, so that every human and brute creature is engendered under a kind of water. The matters of metals are concealed in such a way that it is impossible for man to distinguish them before they are congealed, just as no one can tell that water in which salt is dissolved is saline without tasting it with his tongue." Then, replying to the alchemists who had recourse in their experiments to the highest furnace-temperatures then known, Palissy added, "When you have tried everything by fire, you will find that my saying is true, that water is the beginning and origin of all natural things." One could not reason more ingeniously respecting an idea wholly of the imagination, but which could hardly have been sounder, at a time when, chemistry not having yet put on a scientific character, the nature of the substances whose origin it was sought to ascertain was still almost unknown.

Struck by the admirable regularity of the motions of the stars, a number of minds were led, by a mystical generalization, to draw from them consequences applicable to the phenomena of our planet. According to a doctrine that goes back to the Chaldeans, and is also found among the Egyptians, sidereal influences contribute to the maturing (that is, to the subterranean transformation) of mineral substances. Mysterious relations were supposed between the celestial bodies of our solar system and metals, the luster of which has some resemblance to the color of the stars. Conformably to the principle of likes, gold corresponded with the sun, silver with the moon, iron with Mars, copper with Venus, lead with Saturn, and tin with Jupiter. Strange as it may seem, this fancy had not been abandoned two centuries ago. An old German practical miner's manual, the "Bergbüchlein," the earliest known edition of which is dated in 1505, contains figures in which metalliferous veins may be seen running into the interior of the earth, and in the sky the planets which correspond respectively with the various metals, and from which the generative effluviæ are flowing. "With the birth and growth of a metallic mineral," it is said in the book, "are involved, on the one side an agent, and on the other a subordinate substance or matter, which is capable of being set into activity, like something in fermentation. The general agent is the sky, with its movements, the revolution of its planets, and its luminous radiation. This is why each metallic

mineral is subject to a special influence from its particular planet." Thus, in a little work of only a few pages, and which was simply intended to give the most necessary knowledge to the practical miner, was placed for the same consideration of utility as determines the employment of the compass, the notion of this pretended affinity between the metals and the planets.

The mode of formation, or, as Buffon said, the genesis of minerals is one of the most interesting questions of their history. But the problem could not be approached until geologists had furnished precise data on the conditions of their bearing. Satisfactory solutions have recently been obtained in the case of a certain number of mineral species. Synthetic experiment, placing itself in the circumstances that seem to have presided at their formation, has succeeded in reproducing them, with their crystalline forms, and all their essential characteristics, and has thus completed the demonstration of their origin. By means of this method of demonstration, we have been able to ascertain that many minerals are due to the action of subterranean waters. From the most ancient epochs, these waters have circulated through the crust of the earth, where they have left, at a multitude of points, signs revealing the part they have played, and the course they have taken, even more clearly than contemporary phenomena have done.

The sedimentary beds, formed like the deposits which the sea spreads every day in the bottom of its basin, are often distinguishable from one another, even at first sight, by certain exterior characters. The differences are, for the most part, produced by the action of subterranean waters, as is demonstrated by the animal and vegetable fossils, which were for a long time designated as petrifactions, or, rather, by the chemical changes which these fossilized bodies have evidently undergone.

Here, shells and corals, showing forms perfectly preserved down to their slightest details, are no longer composed of carbonate of lime, as they certainly were during the life of the animal to which they belonged, but are essentially different substances, quartz having entirely taken the place of the calcium carbonate. There are also other minerals, such as pyrites and sulphate of baryta, which have penetrated and crystallized within the cavities which the bodies of these invertebrates occupied.

The silicified woods, which are very frequently met, assert still more clearly the intervention of a liquid. Not only can the least trained eye recognize their external shape, but the ligneous texture also is still maintained, even to the cells and other inmost parts, as distinctly as in the living wood. It is not, then, a simple molding of silica, performed in the vacant spots that have been left by the disappearance of the vegetable substance, but the ef-

fect of a molecular substitution, gradual and slow, which has preserved to us the most delicate organs of various plants. A liquid, such as water, has been able of itself to produce these substitutions of one body for another, by depositing the substances which it held dissolved.

Changes due in like manner to an aqueous influence have induced the formation of the rounded bodies called nodules, which have been sometimes confounded with organic productions, although they are wholly mineral. Flint, which is a variety of quartz, often appears under a tubercular form. Nodules of it are found, in a parallel alignment to the structure of the chalk, in the chalk-beds of England and France. They have been produced subsequently to the deposition of the strata, and have often imbedded fossils upon which they have molded themselves. There are also calcareous nodules that have been produced in a similar manner. The most recent quaternary deposits, like the diluvian clay, or loess, present a large number of them. The same form appears very frequently in the carbonate of iron, which is particularly abundant in the clays of the coal-beds, and is mined in several counties of Great Britain. These balls may be recognized by their metallic luster and brassy color, and their surface spiked with crystalline points. They are formed of pyrites or bisulphuret of iron, and abound in the chalk, the plastic clay, and the carboniferous rocks. When, as the result of denudations, they appear isolated on the surface of rocks of an entirely different nature, people have sometimes been led to suppose them fallen from the sky; and so they have been given, in some parts of France, the vulgar names of thunder-stones or aërolithes. The substance which has been formed into these concretionary forms appears to have been subjected to the influence of a liquid vehicle, like quarry-water, or the water which has been imbibed by rocks. The tendency of dissolved matter to agglomerate, under the influence of attraction, into a spherical shape, has been opposed by the unequal resistance of the mass from which it isolates itself. Hence, the tubercular forms.

In the case of the blackish coatings called dendrites, the forms of which bear a deceptive resemblance to those of mosses, the deposit is wholly inorganic; water, branching out by capillary attraction through extremely minute cracks, has deposited oxide of manganese in them.

The marbles called veined give evidence of another mode of action of subterranean waters. Their varied aspect is due to little veins of white crystalline carbonate of lime winding around in a mass of dark color and amorphous character, but of the same chemical composition. Fissures, intersecting in every direction, are first produced in the rock, under the influence of mechanical

actions; the cavities thus opened have served as channels for waters which, on their passage, have dissolved a part of the substance to deposit it afterward purified by crystallization—a fact very much like what we habitually observe in our laboratories. This mode of veined structure is most frequent in the limestones of regions that have been dislocated. The Alps furnish many examples of it along escarpments of a considerable extent.

Modifications have also been imposed upon the eruptive rocks, under the influence of the waters that have traversed them; but they are of a different character from those that we have been considering, not only on account of the heat that has prevailed among them, but also on account of the composition of the rocks. Various mineral species, grouped under the name of *zeoliths*, may be observed among the eruptive rocks, as crystals adorning innumerable cavities, such as we may see produced in existing volcanic lavas, by the disengagement of the vapors which these lavas exhale down to the moment when they are completely solidified. It is easily seen that these *zeoliths* were not formed at the same time as the mother-rock, but after it had become consolidated and turgid. They always assume the same disposition, whatever the age of the rocks. Sometimes agate is associated with them, as at Oberstein, in the Palatinate, where that stone was mined in antiquity, and in Uruguay, where it is extracted at this time. Its concentric zones, laid one upon another in successive moldings, testify clearly to a gradual deposit, evidently of an aqueous nature. Waters of incrustation are producing under our eyes deposits of carbonate of lime of identical structure. The varied colorations of the successive zones of agate which are utilized in the making of cameos correspond with very slight variations in the nature of the precipitant liquid. The limpid crystals of Iceland-spar, to which physics is indebted, since Huygens, for most important discoveries in double refraction and the polarization of light, are associated with *zeoliths* in the cavities of ancient lavas, and originated at the same epoch.

We do not any longer have to resort to erroneous or vague conjectures to explain the origin of these minerals, for we have a demonstration, that might be called experimental, which throws the clearest light on all their details of it. The excavations made at Plombières in 1851, to increase the flow of the springs, brought to light in the deep trenches of the subsoil a part of the old Roman underground conduits that had escaped the ravages of the barbarians. They also disclosed a masonry-work of *béton* and bricks carefully built around the thermal springs, so as to isolate them from the neighboring river and the gravel, in which they were in danger of being scattered and cooled. Every spring imprisoned in this masonry, as it rose from its source, could only

escape, to flow on to the fish-ponds, through a vertical chimney of cut stone. Carefully examining the bricks which had been immersed for centuries in the mineral water, I discovered that they had undergone a transformation of the most interesting character. New combinations, silicates of the family of the zeolites, had been developed in the cavities with which the bricks were riddled; chabesite in striated crystals, grouped exactly like those in Nature, and with the same angles; and christianite, the crystals of which, intersecting one another in the form of a cross, are identical with those of the volcanic rocks. There was, besides, a product of opal, translucent and colored like drops of dew. The tissue of the bricks contained little fibrous and radiated globules, which optical characteristics showed to be chalcedony. The same species had been formed even in the minutest pores of the brick. These minerals, of contemporaneous production, were found later in the Roman masonry-works of Luxeuil and Bourbonne-les-Bains. With the aid of time, thermal water had there acted chemically on the bricks and on the limestone, and had engendered gradually and by a curious collaboration the substances we have named, without calling in the high temperature that we were ready to suppose was necessary, nor water very strongly mineralized. A very slow but incessant action was sufficient. Does not this demonstration, even to the minutest particulars, account for the formation in ancient epochs of zeolite, agate, and the substances that usually accompany them? In view of their complete similarity with those of which Plombières has revealed the history, can we not say that all these minerals were reproduced in rocks still incompletely cooled, by the chemical action of hot or lukewarm waters which infiltrated themselves into their easily permeable texture, and of which the parasitic zeolites accurately trace the ancient history?

On account of the multiplicity and extent of the works of exploitation that traverse the metalliferous beds in numerous countries, and the mathematical exactness with which all the details of their forms and composition are revealed every day, these beds bring to bear very precious data on the functions as mineralizers of the ancient springs. The veins of the most usual type have the form of plaques rarely exceeding a few metres in thickness. Horizontally, they are prolonged to considerable superficies, sometimes to ten or fifteen kilometres. This measurement is given by the extent to which workings have been promoted, and can be visibly exemplified on the surface of the ground, when the quartzose parts of the veins, persistent against denuding agencies, appear as steep ridges, of imposing height, which the eye can follow in the distance. Sometimes they stretch out like a gigantic wall irregularly notched, sometimes they rise in needles. In

depth, the veins are prolonged indefinitely, and mining excavations, however deeply they may be carried, fail to reach their lower limit.

At first sight, metalliferous veins contrast in their mineral composition with the incasing rocks, to whatever category they may belong, even when they are welded to them. They are formed of very different minerals; and it is necessary to distinguish in them the useful substances or minerals, and the stony matter or gangue. The last very often occur in a decidedly predominating proportion, and much that is unforeseen in the returns of a mining operation results from their variations in quantity and richness. The various substances constituting veins sometimes assume a symmetrical disposition in respect to the two walls, showing that they result from deposits made successively one upon another, as happens in a crystallizing pan or in fountain-pipes that are incrusted with stony substance.

Metalliferous veins are rarely isolated, but usually form systems or groups, connected by a bond of parallelism and by similarity of composition. They occur exclusively in regions that have suffered dislocations, of which they appear as if they were a consequence. The constitution of the soil of France well brings out this correlation. While veins are wanting in the districts in which the beds have nearly preserved their original horizontality, they are found by thousands, although of inferior richness, in the central plateau, the Vosges, the Pyrenees, and the Breton peninsula. They often border upon the eruptive rocks, with which they are visibly connected as if by a bond of relationship. Many countries famous for their metallic riches, like Cornwall, Hungary, and the State of Nevada, furnish striking examples of this last alliance.

Metalliferous veins betray their origin by their forms and the independent manner in which they cut rocks of every kind. Their formation is due to large vertical breaks, called faults, which have given an outlet to the substances and have ultimately been filled with them. The concomitance of the veins and of grand dislocations sufficiently testifies that metallic matters and their gangues have been brought from down up, that is, from the deeper regions of the globe toward the surface. From this fact, it was at first inferred that the ascension of the vein-filling minerals was accomplished by sublimation or at least by fusion, but this has been shown by many circumstances to be inexact. The specimens of the collections teach of themselves alone that their various minerals have been precipitated one after another, distributing themselves in an order quite different from their degree of fusibility and volatility. It should also be observed that the greater part of them are found outside of the veins, and in circumstances in

which they can not have been deposited except by the intermediary action of water.

These views, which the direct observation of Nature had suggested to Elie de Beaumont, have been experimentally verified by De Senarmont. Working with close tubes under pressure, and at a temperature very much higher than that of boiling water, this eminent observer succeeded in reproducing the minerals of the veins from the most common substances—quartz, sulphate of baryta, fluor-spar, iron and copper pyrites, blende, sulphuret of antimony, glance, spathic iron, and carbonate of zinc; all of which laboratory-minerals, in a crystallized condition, quite resembled the analogous natural minerals. The fact of the contemporaneous formation of many of these, as exemplified in the basins of existing springs, as at Bourbonne-les-Bains, come later to confirm and complete this demonstration. Deep fractures or faults, which so numerously furrow the crust of the earth, have therefore endured various destinies in the series of the ages. Some have remained empty, or have been filled only with fragments detached from their walls. Others have furnished a way of exit for fluid eruptive rocks, basalts and porphyries, for example; and, finally, there are those with which we are now concerned, which have served, by the intervention of water, as channels for metalliferous emanations.

These emanations have not been borne exclusively into faults. Sometimes they have filled interstices of irregular and various forms, thus constituting ore-bearing masses, now adjoining eruptive rocks, as if they had followed them, now incased in stratified beds. Whatever their forms, these masses are often in relation with faults which have served as vents for emanations, partly watery, from the interior of the earth.

Among the metalliferous deposits of the last category, some, still better than the veins, demonstrate the intervention of mineral or thermal waters. The masses of hydrated peroxide of iron, frequent at Berry, where the Romans mined for them, and in Périgord, Lorraine, Franche-Comté, and other districts, have been attributed, with much probability, to the presence of gaseous springs, in which iron was dissolved as a bicarbonate. The form of globules with concentric laminations, or pitholiths, which they affect, strikingly resembles the little spheroids of carbonate of lime that are deposited every day in the basin from which the thermal springs of Carlsbad gush and whirl. At times we may recognize clearly that solutions of peroxide of iron have acted upon the limestone which they bathed, for they have gradually corroded it. This chemical action has also been exercised on animal and vegetable matters. At many places in Alsace the mineral contains minute fibrous fragments consisting of woody rem-

nants, or the wood, without losing its texture, has been completely replaced by peroxide of iron and quartz.

Nothing is clearer than the intervention of subterranean waters in the origin of many masses of calamine, in which zinc occurs in the condition of a carbonate and a hydrated silicate, at Veielle-Montagne, for example, not far from Aix-la-Chapelle. The mining works have enabled us to recognize and follow the channels of the generating springs in all their details. The calcareous walls between which they made their way have been attacked, and, as we have just seen to have been done with peroxide of iron, zinc-mineral has been gradually substituted for carbonate of lime. The springs that held the mineral in solution issued from faults, and insinuated themselves into the permeable strata, flowing upon the surface of the impermeable beds. Vestiges of fossil shells, sometimes including the minerals of zinc and lead, in Westphalia, for example, likewise attest the substitution of metallic combinations for limestone. The lead and silver mines of Laurium, one of the principal sources of Athenian wealth, which figured in the budget of that state from the year 520 B. C., have revealed, perhaps still more evidently, in their vast excavations, the same processes of Nature.

Similar instances occur in many other countries. We cite in France the various calamine beds on the circumference of the central plateau; and, in the United States, in the Rocky Mountains, the important beds that have given rise to the towns of Eureka and Leadville. Notwithstanding local differences, all these masses of calamine present striking analogies, quite independent of the age of the beds in which they are spread. The metallic sheets are always in the same relation of situation with respect to the permeability and chemical nature of the rocks as they would be to-day, if the metalliferous waters were continuing to flow. It is thus made possible to determine exactly all the ruling conditions of these ancient zinc-bearing streams.

Phosphorus is most usually found in the crust of the earth in the state of phosphate of lime or phosphorite. It is extracted for the wants of agriculture from certain layers of the stratified beds and in the cretaceous formation, particularly in the beds called the gault, the same as those from which flows the water of the well of Grenelle. This mineral has been worked very actively since 1855 in several of the departments of France, in England, Bavaria, North Germany, Russia, Spain, and Poland. It also exists in remarkable quantities in the Jurassic. It often, in these beds, contains animal forms, as of bones, indicating that it has passed through life. But when it appears in eruptive rocks and metalliferous veins, its origin is wholly independent of the action of organized beings. Like the metals, the phosphorus now

contained in the sedimentary beds originated chiefly from the interior reservoirs of the globe, whence it has also been brought by the agency of thermal springs. This is illustrated in the important beds of Estremadura, where phosphorite associated with quartz constitutes numerous vertical veins, which have been filled up from below. Incidentally, the substance has penetrated the calcareous strata, and has assumed the forms of fossils within them, thus bringing a new proof of aqueous precipitation.

Still more frequently than any other substance, is quartz distributed in large veins. The granitic plateau of France, Brittany, the Vosges, and the Pyrenees presents numerous examples of it. These veins can often be perceived from a considerable distance. Besides crystallized quartz, they frequently contain parcels of metalliferous minerals, and thus represent transitions toward metalliferous veins proper. The ribboned texture of chalcedony and agate, which abound in these veins, and the manner in which they are related to deposits of precisely the same nature, inclosed in adjoining strata, confirm the view of their aqueous origin and permit their age to be determined. This is exemplified in the department of the Loire, where these veins are thus associated with porphyry, and at the northern point of Morvan; and in the remarkable quartz-veins of the Sierra Nevada, in California, which are auriferous at some points. Comprised within a zone some nine or ten miles wide, they extend from north to south along the chain for nearly two hundred miles. One of the most considerable of these, "the great quartz-vein," can be followed over more than thirty-five miles.

In fact, all these outflowings of quartz and connected minerals, whatever may be the diversity of their forms, in veins, masses, or strata, attest, not less authentically than the metalliferous beds, the intervention and generative power of subterranean waters which have been long since exhausted. We shall next see that waters sufficiently superheated deposit as quartz-crystal the silica which they hold in solution. It is thus explained how this mineral has in a certain way become the binder-up of the fractures of the terrestrial crust.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

A CONNECTION may be hypothetically traced between the frequent earthquakes in South America and certain subsidences which appear to be going on in the Andes. The city of Quito has sunk 26 feet in 122 years; the farm of Antisana—the highest inhabited spot on the globe—165 feet in 64 years; and the peak of Pichincha 218 feet in 122 years. The squeezing of the crust of the earth which is produced by such sinking of the masses of these ranges must produce violent dislocations in the surrounding regions; and these are the terrible earthquakes which we witness.

WRITING-MACHINES FOR THE BLIND.

By ARTHUR GOOD.

A NUMBER of philanthropists before Valentin Haüy had thought of various means of facilitating the education of the blind and placing them in relations with seeing persons; but, ingenious as their isolated attempts may have been, the necessary cohesion to constitute them a single whole was lacking in them, and they were destined to disappear with their authors. In the sixteenth century, Lucas, of Saragossa, conceived the idea of tracing the letters of the alphabet in hollows on wood. Moseau, of Paris, in 1640 devised the first characters in relief, but he was not encouraged, and gave up his experiments. The English blind scholar Sanderson constructed the first calculating tablets. Diderot tells of books which were printed by Prault for blind Mlle. de Salignac, who died in 1763, but gives no further details on the subject. We are likewise ignorant of the methods followed by Bernouilli, at the beginning of the seventeenth century, for the instruction of Mlle. Valdkirk. The obscurity which prevails concerning these essays made in times so near our own shows that they did not become general, either because the methods were not practical

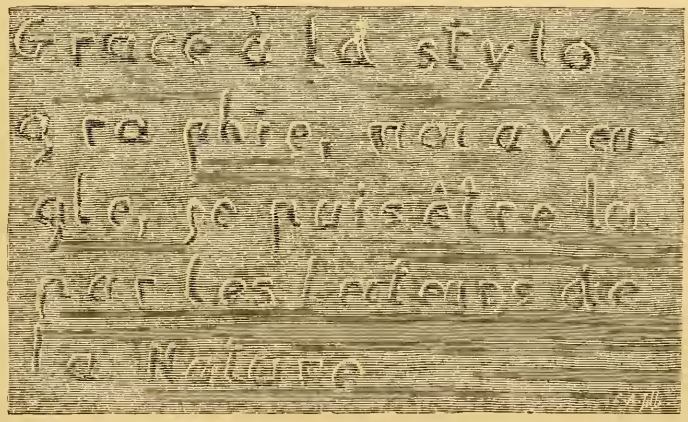

Fig. 1.—Fac-simile of a Stylographic Inscription in Relief, written by a Blind Man for the Journal "La Nature."

enough, or because they were not pushed with sufficient energy. The methods of Haüy and Louis Braille were more successful.

Valentin Haüy, born in 1745, was a brother of the celebrated mineralogist, to whom we owe the "Crystallography." Struck with the success of the labors of his contemporary, the Abbé de l'Epée, for the deaf-mutes, he resolved to give to the blind also facilities for instruction and means to cultivate their minds. By

an inspiration of genius, he conceived what might be asked of the touch, which is so marvelously developed in the blind. Having made some characters in relief representing the letters of the alphabet, he undertook, in 1784, the education of a blind mendicant named Lesueur. The pupil's rapid progress soon made the inventor's name celebrated. This attempt was the origin of the Institution for the Blind in Paris.

Louis Braille, son of an artisan, like Haüy, completed the work of his predecessor. He was born at Compvray in 1809, and lost his sight, when three years old, in consequence of an injury he received from a knife. He entered the Paris Institution for the Blind in 1819, and became distinguished as a pupil, and afterward as a professor. He published, in 1829, his admirable "Anaglyptographie," or method of reading and writing by points in relief. He was inspired to this work by observing the cryptographic system devised in 1819 by Barbier, the artillery-officer, and constructed a method of admirable simplicity. It is equally well adapted to manuscript work and to printing: it can be applied to orthographic writing, to stenography, to mathematics, and to music. It has been used in printing books since 1849, and is still very generally in favor.

The basis of the alphabet is a group of six points arranged in vertical lines of three each, like the six of dominoes, which are numbered downward, beginning on the left hand, thus:

```
1 . . 4
2 . . 5
3 . . 6
```

A first series of ten figures, obtained by a methodical combination of the four upper points, 1, 2, 4, and 5, constitute the fundamental signs.

```
. . . . . . . . . . . . . .
. . . . . . . . . . . . . .
a b c d e f g h i j
```

Adding point 3 to these characters, we get the signs of the second series, embracing letters from *k* to *t*. The addition of the points 3 and 6 furnishes a third series; and a fourth series may be obtained by adding the point 6 to each of the first ten characters. The points 4 and 6 placed before a letter make it capital; and there are signs for the punctuation-marks.

The numerical sign, composed of the points 3, 4, 5, and 6, changes into figures or numbers the signs or groups of signs of the first series which it precedes. Thus, the letter *a*, preceded by this sign, becomes the figure 1 `. .` `.` `. .`; the letter *b* figure 2, etc. The number 1234, for instance, would be written by prefixing the numerical sign to the group of letters *a b c d*

```
. . . . . . . .
. . . . . . . .
. .
1234
```

The ordinal numbers are formed by using the points 2, 3, 5, and 6. Fractions are expressed by writing the numerator as a cardinal, and the denominator as an ordinal number. But Braille's numerals are not well adapted to mathematical calculations, for they make the operations too long and difficult. An adaptation of them to music is more convenient, and is strikingly different from the blind-man's notation described by Guillié. It represents the measures by button-molds, the values of the notes by pieces of cork of various thicknesses, a round note by a ring, a black note by a piece of money, rests by thongs of leather, etc., the whole being strung on a long cord.

The characters, printed or written in relief, are read by the inner side of the end of the forefinger of either the right or the left hand, the hands being held open over the page.

The Braille or anaglyptographic writing was done on a paper which was fixed upon a tablet of wood or metal with an undulating surface presenting parallel, horizontal, and equidistant grooves, of a uniform depth, and about as large as a school-slate. The wooden frame of this tablet is bored on the sides with holes at equal distances apart, into which are fastened with pins the ends of a guide. The guide is furnished with two rows of rectangular openings of the size of the generator sign of the Braille alphabet, while the width of the grooves in the plaque is so calculated that the height of the openings in the guide shall correspond with that of the grooves. The blind writer, holding vertically in his hand a stylus with a rounded point, forms in each of the openings one of the signs he desires to write; in consequence of the slight depth of the grooves, the stylus gives to the paper, which should be of suitable thickness, enough relief to make the writing legible without piercing holes in it. After each word the operator should "jump" an opening so as to give the needed space between that and the next word. The two lines finished, he lifts the guide lightly, and slides it along the frame till the pins drop into the next holes, when he is ready to begin two new lines. It should be remarked that the characters are written in hollows, and have to be read in relief. The writer is therefore obliged to write on the reverse of the paper and form the characters from right to left, in order that they may be read from left to right, as is the usual way. Some blind persons have written the equivalent of one hundred Alexandrine lines an hour on the Braille machine. Various forms have been given to instruments on the Braille principle, some of which are represented in the engraving (Fig. 2). In one kind the upper edge of the paper is held in a board which is hinged to the upper end of the frame. In another kind the paper is fixed between two frames which are boxed into one another, so that when one side has been written upon (*recto*) it can be turned and written

upon the other side (*verso*) in the interlinear spaces. This system vastly increases the capacity of the sheet of paper. There are also pocket tablets, or replets, of which different models are represented in the engraving; they are for the most part strips of undulated zinc, to which are hinged guides bearing several rows of openings.

Signora della Casa, an Italian woman, constructed the apparatus represented in the first figure of our engraving (Fig. 2). A

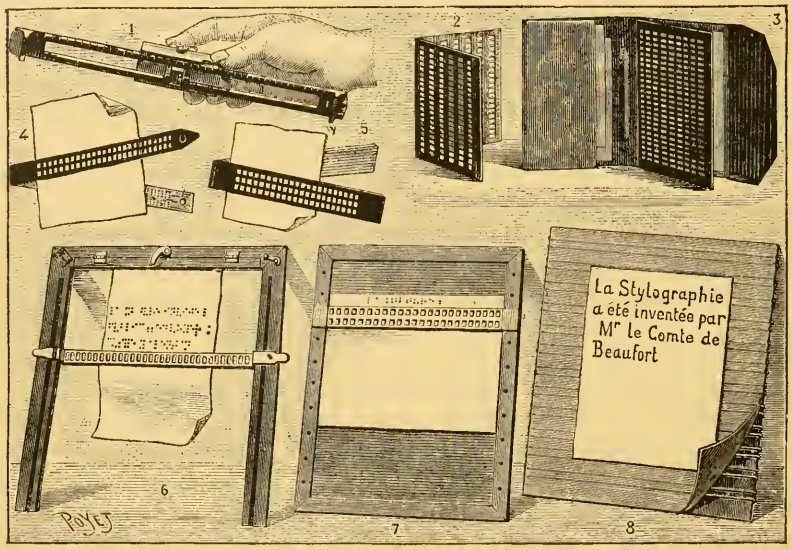

FIG. 2.—VARIOUS APPARATUS FOR WRITING BY THE BLIND. 1. Signora della Casa's piston-guide. 2. Recto-verso tablet of Laas d'Aguen. 3. Goldberg's Danish tablet. 4. English reglet. 5. Ballu's reglet. 6. Austrian tablet. 7. Braille's tablet. 8. Beaufort's stylograph.

little carriage bearing six buttons, which control as many movable pins, glides along a ruler that is notched at equidistant intervals. When one of the buttons is struck with the finger, the corresponding pin springs out and makes a point on the paper. A spring brings the pin back, and after the writing of each sign, the carriage is slid on a notch along the guide. But this apparatus is not in use, and we mention it only as a curiosity.

When we wish to write to a blind man by the Braille alphabet, we can accustom ourselves to reverse the signs by copying them as they look in a mirror; or we can use a table composed by M. Merricant, of Toulouse, which gives the characters written both ways; or we can learn only the reversed alphabet, and read the writing, if we have occasion to read it, on the hollowed or reverse side of the sheet, or the side on which it is written, which, with the eyes, will be easy enough.

For the use of blind in writing to seeing people, designs have

been invented in which the writer traces with a pencil the characters of the usual alphabet, assisting his pencil by guides pierced with openings. In the German system of Hebold, the letters are written in squares that are notched in each side. In the English Moon tablet, which is composed of narrow strips of wood glued

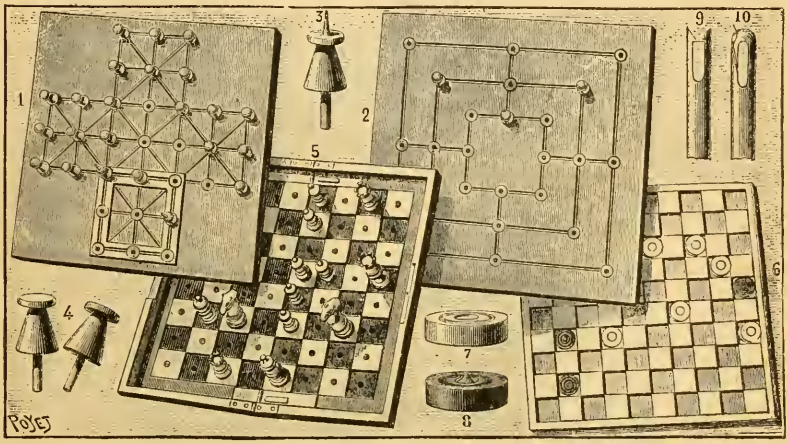

FIG. 3.—GAMES FOR THE USE OF THE BLIND. 1. Fortress. 2. Go bang. 3 and 4. Pawns. 5. Chess. 6. Checkers. 7 and 8. White and black checker-pieces. 9 and 10. Needles for the blind (much magnified).

upon cloth, the strips serve as rulers, or guides, along the edge of which the line is written, each one being rolled up when the line is finished, to give place to the next strip at the proper interval for the next line. Pencil-writing has likewise been studied by Guldberg in Denmark, Galimberti in Italy, and Bourgougnon in France. Valentin Haüy devised a method of pencil-writing by placing the paper upon a frame, in the interior of which were stretched parallel cords of catgut; between these cords may be traced signs of corresponding height. In Duphan's instrument narrow strips of cardboard are pasted at equal distances upon a thicker sheet. The paper having been placed upon this widely furrowed tablet, the blind writer feels with the point of his pencil the edges of the strips that are in relief.

None of these systems, however, permit the blind man to revise what he has written. A writing in relief is what is wanted, which should be readable by seeing persons not initiated in the Braille system, and which the blind man too could trace and read with facility. Such a system is provided in the stylography which the Count de Beaufort has invented (Fig. 2, No. 8). The apparatus, or stylograph, is of the simplest character, and can be made at home by almost any one. Cover a sheet of paper with a piece of thick cotton cloth; stretch this sheet over a series of parallel horizontal wires or cords about four millimetres apart; place upon this tablet

a sheet of paper, and with the stylus trace the letters of the usual alphabet, rounding the angles and neglecting the connections. The relief of the cords permits the letters to be made of equal height. After a short period of training, lines of letters can be written in *intaglio* for the blind man to read, by turning the paper over, in relief. If any difficulty is met in writing inversely, let it be done

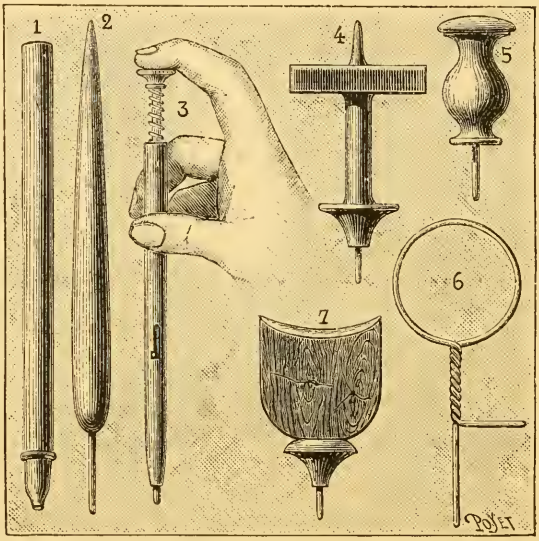

FIG. 4.—STYLUSES. 1. Austrian hollow stylus. 2. Stylus for the Goldberg tablet. 3. Ballu's stylus with an effacer. 4. Another model by Ballu, with a wooden effacer. 5 and 6. Common models. 7. Danish form.

in the regular order, and the blind reader, who has been accustomed to reverse his Braille characters, will have but little difficulty in making them out in their inverse shape.

Among other systems of writing for the blind, the most important is the English system, invented by Moon in 1847, and in which the first journal for the blind was printed. The signs are composed of points set very close together, or of lines in relief, reproducing simplified forms of ordinary letters. The Braille system has been introduced into England by Dr. Armitage, and is spreading in the English colonies. Germany, where the usual writing printed in relief was formerly used, definitely adopted the Braille system in 1879. It has been introduced into Russia and the Scandinavian countries. It is used exclusively in Italy, Belgium, and a part of Switzerland, and has been adopted in a few schools in the United States for music, while for the alphabet it has been modified or other systems are used.

The raphigraph is a machine devised by Braille and Foucault to facilitate communication between the blind and seeing people. It consists of a key-board with ten keys ending in needles and act-

ing with a perpendicular movement, which, for the formation of the written signs, is combined with a horizontal governed by the key-board, which moves a crank-screw. The paper is borne upon a carriage which changes place from line to line. Each graphic sign is numbered according to the needles that have to be struck to produce it. To form, for instance, the letter H with this machine, twenty marks have to be made, with as many strokes on the keys, and perhaps half as many displacements of the horizontal. The machine is too complicated to be practical.

Experiments were made by Hassenfratz in 1783, and Challaut in 1820, in using thick inks in writing which should produce a relief on the paper after they had dried; and the Abbé Vitali manufactured an ink which would give relief enough to be felt by the

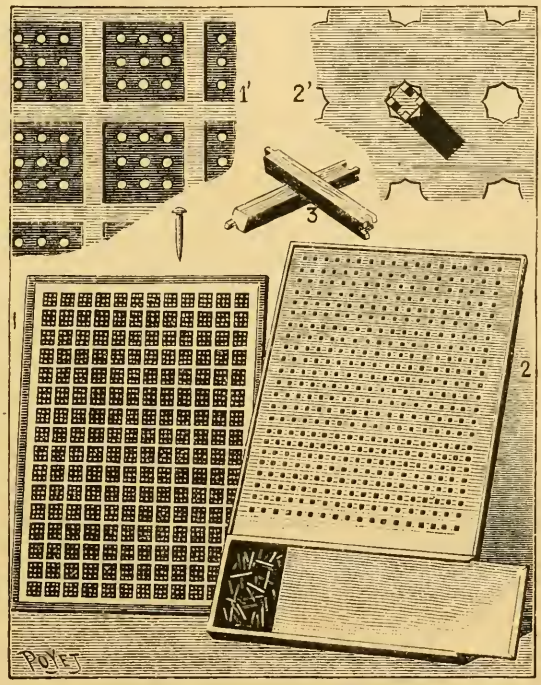

FIG. 5.—CALCULATING INSTRUMENTS FOR THE USE OF THE BLIND. 1. Ballu's tablet: 1′ detail of the squares, a pin. 2. Oury's tablet: 2′ detail of the octagons, red pins.

finger of the blind man. It has not been found convenient for writing, but has been applied with advantage to the drawing of geometrical figures, and for maps. Some of the most successful maps have been prepared by M. Trouillard, who uses linoleum, and indicates the rivers by iron wires, and mountains by more or less prominent undulations. The place of each city, the name of which is indicated by the initial letter in "Braille," is marked by a peg split at the top. A thread attached to the point that indi-

cates Paris, for example, can be fixed for the moment in these splits, as an aid in tracing the railway lines and measuring the distances between the several cities. Laas d'Aguen, in 1847, invented a kind of map which could be reproduced by printing. Previous to his, MM. Pignier and Boher Keller impressed maps in relief on thick paper, in which the meridians and parallels were represented by fine threads, boundaries by round points, mountains by large oval points, and seas and lakes by striæ. This method was adopted by the Moon Society in England and by the British and Foreign Blind Association, the first of which published atlases of terrestrial and celestial maps. M. Kunz, of Illzach, and M. Abel Pifre, of Paris, have published some most excellent maps, the former of which are very cheap, and the latter, the best of their kind, high.

M. Ballu took up some years ago the idea of Sanderson's tablet, for making arithmetical calculations. It is composed of a plaque divided by prominent metallic lines into many little squares pierced by nine holes arranged in threes, and numbered from 1 to 9 (Fig. 5, No. 1, 1′). Pins may be inserted into these holes, the

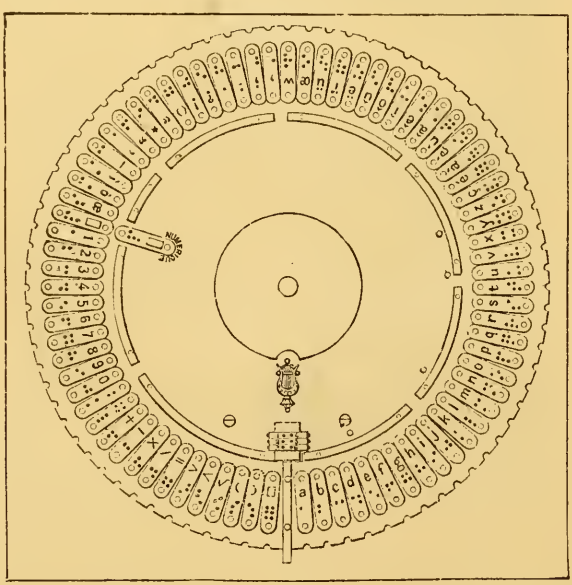

Fig. 6.—Plate of the Mauler Machine.

rounded heads of which project above the surface of the plaque, and indicate the figures from 1 to 9, according to the number of the hole they occupy. The system is simple, but it takes a considerable time to learn it. In Taylor's tablet, the metallic plate is pierced with stellated octagonal holes, in which square pins with beveled ends are set, one of the ends being smooth and the

other toothed. As each pin can be disposed in the holes in sixteen different ways, it is easy to see that the system has considerable capacity. But the blind find it difficult to adjust the pins. A case has been made for working in vulgar fractions, in which metallic figures are set in square holes; but the apparatus can hardly be called a practical one. M. Oury has devised a modification of Taylor's tablets which has advantages over both of these instruments (Fig. 5, No. 2, 2′). M. Mauler's writing-machine consists essentially of a horizontal plate, having on its circular border a series of keys, each of which bears one of the

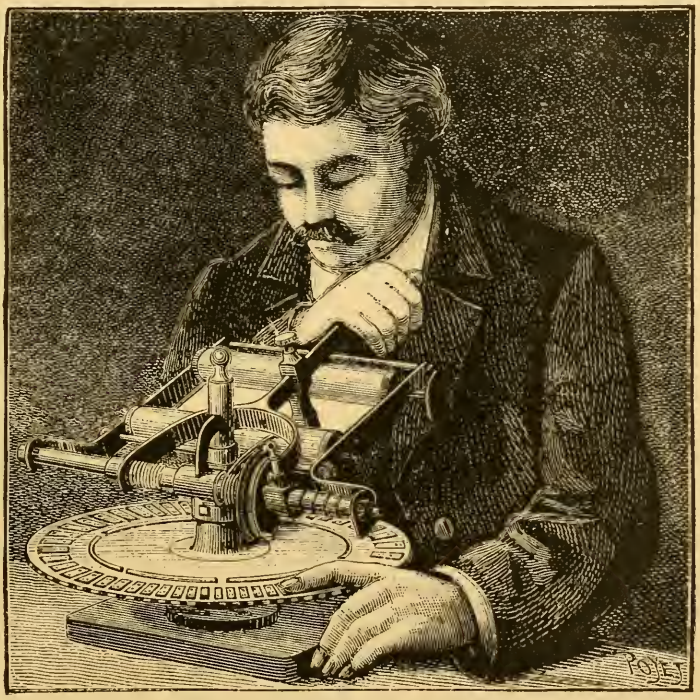

Fig. 7.—A Blind Man writing with the Mauler Machine.

signs of the Braille alphabet and the corresponding letter of the ordinary alphabet, the two systems being arranged upon two concentric circlets. The plate, turning around a vertical axis, may be fixed at any position for the moment by means of a spring working into a notch. A frame, which turns upon a horizontal axis, supports two rollers upon which the paper is wound, and is moved by a lever which the writer holds in his left hand. Upon this lever slides a little tampon tipped with India-rubber, which may be fixed at will immediately over the line of either of the alphabets of the plate. When the writer has brought the letter he wants in front of him, and has fastened it for the moment in

place, he presses the lever down, bringing the paper in contact with the plate, forces the India-rubber-tipped tampon upon the character with such force as to obtain a relief impression of it on the paper. This done, he repeats the operation for his next character, and so on till his writing is done. This machine has the further advantage that the writer can revise his work by going over it with his fingers, and, if he finds that he has anywhere stamped the wrong character, he can bring the proper character under the tampon, insert the paper again at the spot where the wrong character appears, and, by a single application of the tampon, obtain an impression of the right character, and, with the same movement, obliterate the wrong one.—*Translated for the Popular Science Monthly from La Nature.*

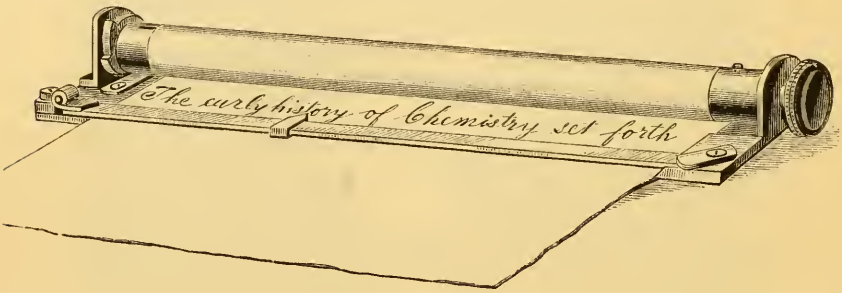

Fig. 8.

[We add an engraving (Fig. 8) of the writing-machine devised by Prof. E. L. Youmans, the late editor of the "Monthly," during his blindness, which he used with much satisfaction till he recovered his eyesight. The sheet of paper is held in a slit in the roller, upon which it is rolled as it is written upon, a line at a time, leaving a blank for the next line, the proper spacing of which is determined by a ratchet. The pencil is kept in a straight course by means of the bar which is shown beneath the writing. The slide seen near the middle of the bar is used to mark the place where the writer leaves off—as at the end of a sentence.—Editor.]

Prof. Judd claims for paleontology the right to be recognized as a distinct branch of science, because it deals with a class of objects and with objects in conditions with which biological methods alone can not cope. Its objects, besides being largely fragmentary, are in a mineralized condition, for which a peculiar knowledge and skill in petrology are required; it has, in the case of each deposit, to study the conditions under which the materials were laid down; and it has to determine the succession of processes to which the materials have been subjected through the ages since their original accumulation. Processes and knowledge are required in the solution of these problems which are afforded by no other single branch of science.

EXPERT TESTIMONY.

By Professor FRANK W. CLARKE.

OF all the causes which tend to discredit science, not one is more mischievous than the policy of the courts with regard to "expert testimony." Whenever a question of scientific fact or theory becomes involved in the settlement of a lawsuit, a swarm of "professional" witnesses are called, who testify on opposites sides, until neither judge nor jury can tell what is or is not really settled. Of these witnesses some are trained, some untrained; some are competent, some incompetent; some are scrupulous, others are unprincipled; and no sure rule of discrimination is properly applied between them. As a rule, all, though sworn, are expected to act like paid attorneys, each serving the side which employs him; and the one supreme test of capacity is that of shrewdness under cross-examination. Strange perversions of science thus get before the courts, to receive equal weight with worthy evidence; doubts are raised or exaggerated, and facts are misstated or suppressed. The highest scientific authorities, the men whose researches create science, are therefore averse to testifying, and rarely appear in the witness-box; for they can not risk their reputations upon one-sided or partisan statements, nor do they like the misrepresentations into which their evidence may be unscrupulously distorted, Under the present usage the expert bears witness for one side against the other; whereas the truth, being "neither black nor white, but gray," may stand in the middle of the disputed territory. The science of the court-room is litigious, not judicial; and no place is found for the unbiased presentation of fact, regardless of its bearing upon the personal interests at stake, and with fair credit given to genuine doubts and uncertainties. To the scientific partisan the court-room doors are wide open; to the scientific jurist they are practically closed, for no one wants his services. In criminal cases, perhaps, a better showing may be made; for here we have an impersonal state seeking to do exact justice, and its experts have no private ends to gratify. If, however, they are incompetent, the criminal, perhaps a poisoner, may escape punishment; and glaring cases of this kind are on record. Any experienced chemist can easily cite examples in point, for prosecuting attorneys are not always able to distinguish between true and false experts, and the latter sometimes destroy the evidence of crime in their blundering efforts to detect it.

Most men of science, and indeed most professional men, have two reputations—the one within, the other without the ranks of their colaborers. The two are rarely, if ever, quite commensur-

able, for popular repute may vary widely from true professional standing, and the quack is often better known to the world at large than the man of really solid attainments. There are quacks in science, just as elsewhere, and these men sometimes have prodigious popular reputations. One of them, widely known as an expert in the courts and on the certificates of patent-medicine venders, was once called upon to analyze a commercial product. "Do you want this sample analyzed to *buy* or to *sell?*" was his modest inquiry! Still another class of experts, having creditable standing among their fellows as regards knowledge and ability, is made up of men to whom a science is a trade rather than a profession; a business in which money is to be made, decently and honestly of course, but with no place in it for sentimentality or unselfish devotion to abstract principles. They enter the court-room, as do the lawyers, to win cases for their clients; not by unfair means or trickery, but by the strongest presentation of the *favorable* evidence. To present, as expert *witnesses*, the whole argument, *pro* and *con*, is not their recognized function. They answer certain questions, which have been carefully agreed upon beforehand; they evade opposing questions as far and as adroitly as possible; but science itself is not a client, and has no true representative in the court.

It goes almost without saying that, if science is to grow and flourish, it must be esteemed and respected by the community. Its advocates, therefore, to protect themselves, must oppose every policy which tends to its disparagement. Nearly every trial in which experts are called is harmful to the interests of science, for its supposed representatives too often forget their duty, and a feeling is spread abroad that all its conceptions are fanciful and uncertain. The disputes of litigation do not add to its dignity. It is, of course, impracticable to abolish expert testimony, even of the crudest and most venal kind; for each side in a suit has the manifest right to submit whatever evidence it can get in its own favor. The problem is, to modify the evil, and to reduce its influence to a minimum. How can this best be accomplished?

From what has already been said it will be easily seen that the position of an expert is different from that of an ordinary witness. The latter testifies to facts which, bearing directly upon the case under trial, are part of his personal knowledge, independently of all abstractions or principles. He has seen a murder committed, he identifies a person or a signature, he met a certain man at a certain time or place, and the like. On most of these points the testimony of the most ignorant laborer is as good as that of the highest scholar, for they relate to the narrowest and simplest kinds of experience, and involve no mental training whatever. The expert, on the other hand, is nearer akin to the

attorney; he testifies to matters which involve more than bare facts, which require special training, and reach out into points of delicate judgment, careful interpretations of evidence, and statements of what is or is not received as scientific opinion. The ordinary witness is well within the range of experience of every man on the jury; the expert speaks of regions into which the jurors have never entered. He testifies, but he also cross-examines, albeit by proxy; for he supplies the lawyers on the same side with himself with questions for the confounding of his adversary. The attorney is merely a legal expert who argues a case for his client, but is not sworn to speak the truth; the expert witness argues, but under an oath which admits of reservations. The two are different in matters of form, but not in matters of practice. They are, in short, colleagues.

Now in the organization of the courts the legal elements have a position of peculiar advantage. First, there are the opposing lawyers, who were once examined for admission to the bar, and who may be disbarred for unworthy or unprofessional conduct. Each argues his case in favor of his client, raising a legal fog or clearing away confusion according to which policy is the better. But over them is the bench, with its trained experts sitting in judgment on the case, deciding all principles of law as controversy arises, listening to and weighing the arguments, and finally, in jury trials, addressing a charge to the jury. The legal questions are discussed by legal experts, and decided by impartial legal arbiters; but the scientific problems which come before a court are subjected to no such arbitration. Just here a line of reform is plainly indicated—not as to the final settlement of scientific questions, of course, but at least as to their proper presentation before judges and juries. Between opposing experts only experts can decide.

Two measures at once suggest themselves: First, that all experts who desire court-practice should be registered, or go through some form of admission to practice, in such a way as to certify in a measure to their having received a proper scientific training. The time of the courts should not be wasted by scientific dabblers or amateurs. Experts should also be liable to something like disbarment for sufficient cause. Secondly, whenever the parties to a suit bring in expert testimony, the court itself should have the right to summon other experts, who, standing in a semi-judicial and non-partisan position, could listen to evidence and arguments, weigh both, and aid the judges either in the preparation of their opinion, or in framing their charge to the jury. So, just as the legal experts pass upon matters of law, the scientific experts would pass upon matters of science, and the results could not be other than favorable. Pretenders, getting less easily before the courts,

would testify less confidently if they knew that all their statements were to be properly reviewed; science itself would be more fairly represented, public interests would be subserved, and charlatanry would be the only sufferer.

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

II.

BEFORE narrating any further natural history superstitions, I wish cordially to thank, one and all, the many readers who have so kindly written, now to express an interested recognition of some belief of their own childhood, and again to send other superstitions from different localities. Such of these fancies as had not already been collected for the present article I gladly insert. The beliefs here mentioned consist more largely than did those described in a previous paper * of such as are shared alike by children and adults.

One correspondent expressed strong doubt as to whether children manifested much originality in their mythical conclusions, thinking that the latter were almost always exaggerated or grotesque distortions of ideas which they had gathered from their elders, often from their nurses. Recognizing the full power of these influences, I must still give the children credit for originating many of the strange notions under consideration. I can not better illustrate this ability of children to form original conclusions, however incorrect, than by quoting from another correspondent, a physician, who says:

"I think I could not have been more than four years old when I began to question myself as to where I came from, and why I was not a boy—for my father, like Mr. Dombey, wanted a *son* for the 'house'—and from my earliest remembrance I have had it impressed upon me that girls were worse than useless things, and that to be something that would grow up into a man was 'a consummation devoutly to be wished.' I wondered what was the difference (and it was a very great difference) between my father and my mother. 'Surely,' I thought, 'there is no greater differerence between my dog and cat, between the horse and cow,' and I reasoned, therefore, that the dog must be the male of the cat, the horse of the cow, the turkey of the hen, and so on. I shall never forget with what complacency I decided in my own mind this great question, nor how reluctant I was to discard it, even when a

* See "The Popular Science Monthly" for July, 1886.

big girl." This is a most unique bit of child's reasoning, but doubtless each of us can recall personal experiences, if less curious, no less to the purpose. Science is constantly extirpating errors and uprooting old conceits, but meanwhile new ones or modified forms of older ones arise; thus, it has come about that some of our New World zoölogical and botanical fables are of recent birth, although very many, especially those that constitute connected myths, are undoubtedly not indigenous, but, as the floras have it, "naturalized from Europe" or "Asia." It would be a labyrinthine task to attempt to trace out, even approximately, the birth and development of some of the latter that still hold extended sway, but many of them certainly are of very remote origin.

There seems to be the best of reason for believing that, to seek the origin of the popular delusion concerning the curative properties of certain animal excreta, we must study the mythology of our long-ago Aryan ancestors. It would not be in keeping with the object of the present paper to occupy the space necessary to give more than a mere suggestion of the character of the great pastoral poem that is embodied in the old Aryan myth which is described in such interesting detail by De Gubernatis in his "Zoölogical Mythology." Probably every mythical or legendary account of the phenomena of Nature is more or less a mirrored reflection of the environment of its authors: so (as we might have expected) we find that the character of the mythology developed on that ancient Asiatic table-land, to which philologists and ethnologists now look back as to the source of the many branches of the great Indo-European family, was a natural outgrowth of the simple life led by the primitive herdsmen and farmers among whom it arose. Dwelling amid abundant herds, which furnished at once their occupation and their principal sustenance, in an atmosphere redolent of the breath of cattle, this pastoral race most naturally transferred the names and attributes of these objects of their daily care to the heavenly bodies and to various meteorological occurrences. The sky, for them, was peopled with cows and bulls, and celestial phenomena were personified in language which was already in daily use, in its literal sense. Thus arose a whole system of zoölogical mythology, in which the animals represented and all pertaining to them bore symbolic meanings. A literal interpretation of certain of these mythical beliefs gave rise to "the superstitious Hindoo custom of purifying one's self by means of the excrement of a cow." Later, the same custom passed into ancient Iran, where the urine of various animals was made use of in religious rites. How much stress the sacred books of the Parsees laid upon this mode of lustration may be gathered from the brief account of the use of the "Nirang," as the liquid in question is called, given in Max Müller's "Chips from a German Workshop."

It has often happened that substances as well as ceremonies, which originally had a religious signification, in later ages degenerated into fancied cures for disease; so, is it not more than probable that the employment of animal excreta as remedies among the less intelligent classes in different parts of Europe, in both earlier and later times, as well as in our own newest offshoot from the Indo-European stem, is a survival of early Aryan religious observances?

Many ignorant people in various parts of the United States to-day believe that a decoction made by steeping in water the manure of sheep is a sovereign remedy in measles, and very similar notions are found among the English and German peasantry. In one of Bale's "Interludes," published in 1562, in which various remedies for common ailments of the lower animals are recounted in quaint verse, the same substance is recommended as "wholesom for the pyppe." In that repertory of curious information, Brand's "Popular Antiquities," the following statement is quoted from a statistical account of County Stirling, in Scotland: "A certain quantity of cow-dung is forced into the mouth of a calf immediately after it is calved, or, at least, before it receives any meat; owing to this the vulgar believe that witches and fairies can have no power ever after to injure the calf." In Cumberland, England, a reputed cure for ear-ache is the application of a bit of wool from a black sheep moistened in cow's urine. Possibly it is a modified form of this latter notion that is found in the island of Mount Desert, where it is said that the wool must be wet in new milk; while in Vermont, to be efficacious, it is thought that the wool must be gathered from the *left* side of the neck of a perfectly black sheep. In other localities negro's wool is a reputed cure for the same pain. It seems almost incredible, whatever their origin, that remedies of so offensive a character as many of those above given can still retain a place even in the rudest traditional pharmacopœia, but there seems to be in the uneducated human mind a sort of reverence for or faith in that which is in itself disagreeable or repulsive. This idea apparently rules instead of rational judgment in the selection of many popular household remedies in the shape of oils of most loathsome derivation, such as "skunk-oil," "angle-worm oil" (made by slowly rendering earth-worms in the sun), "snake-oil" of various kinds, etc. George Borrow, in that rare idyl of vagabondage, "Lavengro," tells of various encounters with an old herbalist who always carried on his back a stout leathern bag, into which he gathered not simples but vipers, whose oil he extracted for medicinal purposes. The faith of this wandering English mediciner and his numerous customers of half a century ago in the viper-oil is quite equaled to-day by that of American frontiersmen in the peculiar virtues of rattlesnake-oil. It is just possible that subtle remedial powers

do exist in some of these oils, but it is not easy to ascertain why lard or olive-oil might not take the place of these disgusting unguents.

The belief in "snake-oil" as a remedy is probably only one phase of the feeling which so often and among such different races has given rise to serpent-worship. Since the publication of a previous paper, in which several popular superstitions about snakes were mentioned, a few additional ones have come to my knowledge. In various parts of New England it is commonly believed, even by people of a good deal of intelligence, that rheumatism and sprains may be relieved by wearing a dried snake-skin—according to some, that of a black snake—about the part affected. The dried skin of an eel is often used instead, very likely from the common misapprehension which classes this fish among snakes. Dried skins of snakes are often kept ready for use in New England barns, as it is currently believed that a portion chopped up and mixed with the food of a cow after parturition will obviate any difficulty there may be in securing the expulsion of the placenta. The cow-boys of the West often wear the rattles of the rattlesnake in their hat-linings as a cure for or preventive of headache—the greater the number of rattles the more certain the remedy. In some parts of England a snake's tooth is frequently carried as a charm against drowning. The belief that sound teeth may be secured by biting into a live black snake I find exists in many places in the United States, both North and South. An interesting Tennessee notion is that the first thunder in the spring "wakens the snakes," and from that time forth one must beware of meeting them. There also ferns are popularly called "snake-weeds," as it is supposed that snakes abound in their vicinity, and so both children and adults are afraid to walk where ferns grow, for fear of being bitten by the reptiles. In the same State it is not uncommon after killing a snake, in time of drought, to hang it on a tree for three days as a sure means of bringing rain. In other localities in the South it is said that the snake must be hung with "its back down," if rain be desired, for if the back be turned skyward it will certainly prevent rain. The belief, so very general in the United States, that any and every species of snake is poisonous, and the bite or "sting" therefore dangerous, is also prevalent in Nova Scotia, and it is there thought that the wound of a snake is certain to be deadly unless the victim can manage to reach water before the snake can, in which case the latter will die, and the person bitten will recover. A common warning throughout New England is, "You mustn't let a snake spit in your mouth, or it will certainly kill you!" The idea that a snake's saliva must be poisonous is quite in keeping with the host of other misconceptions concerning the

powers and qualities of the animal, but the utter impossibility of such feats of expectoration would seem self-evident to the most untrained observer. One not familiar with the unreasonable horror which usually impels people to flee from even the most harmless snake might infer from the form of this injunction that the much-slandered reptiles are frequently kept as pets, and are therefore on such terms of familiarity with human beings as to make it easily possible for this fabled spitting into the mouth to occur. In Peabody, Mass., I have heard of a notion that I have not met with elsewhere—viz., that a snake will not go near where geraniums grow.

A physician formerly from De Kalb County, Ill., reports that illiterate people there believe that a whiff, however slight, of the breath of the "blow-snake" (*Heterodon platyrrhinus*) is "sure death." A stalwart young man, while out hunting, has been known to faint simply because he fancied that a "blow-snake," which his companion was teasing, had reached him with its fatal breath. The blow-snake of Illinois is variously known in other localities as hog-nose, flat-head, viper, and puff-adder. This quite harmless snake affords what I think we may unquestionably call a fine example of protective resemblance, for so cunningly does he mimic the appearance and behavior of some really venomous snakes that his threatening aspect in general strikes terror into the beholder. In Maine, if a cow that has been grazing gives less milk than usual, or than is expected, it is often believed that the common garter-snake has sucked the cow. This strange belief, doubtless, is of remote origin, as it is very common among the housewives of the Russian peasantry.

How great a place not serpents alone, but other reptiles, and batrachians as well, have occupied in the popular imagination as possessors of magical powers, is well shown by the composition of the witches' hell-broth in "Macbeth":

"Round about the caldron go,
In the poisoned entrails throw.
Toad that under cold stone
Days and nights hast thirty-one
Sweltered venom sleeping got,
Boil thou first i' the charmèd pot!

. . . . .

Fillet of a fenny snake,
In the caldron boil and bake;
Eye of newt and toe of frog,
Wool of bat and tongue of dog,
Adder's fork and blind-worm's sting,
Lizard's leg and owlet's wing,
For a charm of powerful trouble
Like a hell-broth boil and bubble."

In the Southern States the bite of a harmless little green lizard (*Sceloporus ?*) is considered fatal. The negroes and poor whites call the little fellows "skyarpins" (scorpions ?). Despite the reputed poisonous nature of these lizards, children are fond of teasing them, holding them at bay with a long stick, and provoking them to "show their money-bags," for, when angered, they have the power to distend and somewhat change the color of their throats. A queer superstition concerning another lizard (the *Zoötoca vivipara*) is found in the north of England. It is there said that if one pick up one of these creatures and touch its back with the tongue, that organ will thenceforth be endowed with a magical power to cure burns. The belief that a turtle can come out of its shell whenever it likes is not uncommon in the Southern States. In Bucks County, Pa., it is believed that if some one's initials be carved on the under shell of a turtle, it will never leave the locality—an excellent example of the *post hoc ergo propter hoc* style of reasoning.

The saying that if a turtle bites you it will not let go till it thunders, is sent me from both Tennessee and Maine. Being found in localities so far apart, I dare say it may be more widespread. In New Brunswick the story goes that the turtle will not let go until sundown. It is a fashion among children, and to some extent among grown-up people as well, along the New England coast, to carry in the pocket a small bone which is called a "lucky-bone." Sometimes this is a small bone cut from a turtle while the animal is yet alive. Again the small, serrated, enameled, and very white bone found in the head of a codfish serves the purpose of bringing good luck. Farther west, in the habitat of the gar, a small bone from the head of this fish is supposed to possess the charm; while in Petit Codiac, N. B., the globular head of the femur of a pig is often kept as a lucky-bone in a box or bureau-drawer. Somewhat akin to those just mentioned is a superstition found among the Russian peasantry, which runs as follows: If a bat which has become entangled in one's hair at midnight be killed, and a small bone in or about the shoulder (I can not ascertain just what one it is) be taken out and carried in the pocket, it will have the power to render the bearer invisible at will.

In one village at least in eastern Massachusetts the passer-by may often hear children call out to their playfellows, if a toad appear on the playground, "Don't step on that toad, or your grandmother'll die!" Less general than the belief that handling a toad will produce warts is the fancy that it will cause freckles. An English superstition is that to carry the head of a frog wrapped in silk will protect one from the gallows. In the neighborhood of Halifax, N. S., the yellow-spotted salamander (*Amblystoma punc-*

tatum) is known as "man-creeper" or "man-killer," and it is thought that each contains poison enough to kill (if given internally) as many men as the animal has spots!

There are a great many stories afloat of snakes having lived for months or even years in the human stomach. I quote the following account from the "Bucks County Intelligencer," Pa.:

"A Connecticut lady tells us that, as a child, she knew of more than one person 'who had swallowed a snake's egg.' The snake grew, and when hungry, would 'cluck' in the throat of its unwilling host. The only way to get rid of the uncanny tenant was for the person to fast until hunger compelled the snake to venture out to a plate of untasted victuals upon the table. This is a genuine myth that no doubt still exists in the central part of Connecticut."

A Massachusetts country girl told me of another case which she said she had never thought of doubting; a lady was long annoyed by the presence of a snake in her stomach supposed to have been swallowed while still very small in drinking-water. She finally decoyed from its quarters the unwelcome occupant by boiling a large dish of milk, over which she bent until the snake came out to feed. Similar myths are common in New England, New Brunswick, and Nova Scotia, in which eels or "lizards" (newts) take the place of snakes. In the "South End" of Boston there lives a man who is nicknamed "Lizard" by the street-boys, because it is currently reported that he for many years unwillingly entertained one of these batrachian parasites. In every instance it is believed that the only relief possible is to coax forth the creature by some tempting dish of food or drink. I can not refrain from quoting verbatim another of these fables which I heard narrated not long since:

"I knew uv a man in Nova Scotia, who wuz drinkin' frum a pond one day, 'nd he swallowed a young lizard that lived 'nd grew in his stomach a long time. At last he suffered so much that his frien's bound um fast t' a tree so he couldn' help umself to water er any kind uv drink, 'nd kep' um fer three days on salt pork. Uv course 't the end uv that time he wuz very thirsty, 'nd ez soon ez his ropes were untied he hurried to a runnin' brook 'nd bent down over the water t' drink, 'nd the lizard came out t' drink, 'nd so he got rid of um."

In the Boston papers more than a year ago this oft-repeated story appeared in a still more incredible form. A bat was reported to have been expelled alive from the stomach of a woman, where it had lived for seven years on a diet consisting chiefly of milk and water. Probably most such fictions could be disposed of in as summary a way as that in which the well-known comparative anatomist, Prof. Jeffries Wyman, is said, in a printed

anecdote, to have dealt with one of these alleged denizens of the human stomach:

"Prof. Wyman, on entering the office of his friend Dr. Augustus A. Gould, an eminent Boston physician, was asked his opinion about a curious case. His friend, a clergyman, had just brought in an animal which he said a worthy parishioner of his, a man of unimpeachable veracity, after some years of suffering in his stomach, had recently vomited, while sitting on a rock in an open field. The animal tried to escape, but was caught. Prof. Wyman at once recognized it as a young blacksnake, which could not have lived years in the man's stomach and then been vomited. The clergyman indignantly denied that his worthy parishioner could be mistaken or would deceive, and wanted to argue the case. The professor said he would not waste time in dispute, and with his penknife immediately opened the reptile's stomach and turned out some grasshoppers, beetles, and other remnants of the usual food of such animals. He said to the clergyman, 'It seems that your parishioner has a liking for a peculiar kind of diet.'" *

HOW THE OPIUM-HABIT IS ACQUIRED.

By VIRGIL G. EATON.

I AM not one of the persons who raise a great cry about the evils of the "opium-habit." I have no doubt that the continued use of narcotics, whether they be tobacco or opium, is injurious to the nervous system; but I also firmly believe that the recuperative powers of the body are such that they can largely overcome any harmful results coming from the regular use of these substances. For instance, I know a stone-cutter who resides at Cape Elizabeth, Me., who for the past twenty years has used twenty cents' worth of black "navy plug" tobacco every day. He is a large, vigorous man, weighing over two hundred pounds. His appetite is good; he sleeps well, and, save for a little heart disturbance caused by overstimulation, he is perfectly healthy, and is likely to live until he is fourscore. He is now fifty-one years of age, and he assures me he has used tobacco since he was fourteen, and never had a fit of "swearing off" in his life. A peculiar and, I should say, a rather troublesome habit of his, is to go to bed every night with a big "quid" of hard "plug" tobacco between

* The writer will gratefully acknowledge the receipt of additional myths of similar character to those here given, with a view to subsequent fuller treatment of the subject. It will be of service if considerable detail be given in regard to the geographical or social boundaries of the superstition, and if the latter be stated as explicitly as possible. (Address Mrs. Fanny D. Bergen, 17 Arlington St., North Cambridge, Mass.)

his molars. As this is always gone in the morning, and the pillow shows no traces of the weed, he thinks he chews it and swallows it in his sleep, though he never knows anything about the process.

There is a widow who keeps a lodging-house in Oak Street, Boston, Mass., who takes three drachms of morphia sulphate every day, in three one-drachm doses, morning, noon, and night. When it is remembered that an eighth of a grain is the usual dose for an adult, while two grains are sufficient to kill a man, the amount she takes seems startling. I asked her why she did not try and substitute tobacco, or bromide, or chloral hydrate for morphine, and she said they made her sick, so she could not use them. This woman is sixty years old, very pale and emaciated. Her appetite is poor. She attends to her duties faithfully, however, and is able, with the help of a girl, to carry on a large lodging-house.

I might give scores of instances similar to the above, but these will do for my purpose. I believe that the person who takes liquor or tobacco or opium, in regular quantities at stated intervals, is able to withstand their effect after getting fixed in the habit, and that it is the irregular, spasmodic use of these articles which brings delirium and death. It is the man who goes on a "spree," and then quits for a time, who has the weak stomach and aching head. His neighbor, who takes his regular toddy and has his usual smoke, feels no inconvenience.

For the past year or more I have studied the growth of the opium-habit in Boston. It is increasing rapidly. Not only are there more Chinese "joints" and respectable resorts kept by Americans than there were a year ago, but the number of individuals who "hit the pipe" at home and in their offices is growing very fast. A whole opium "lay-out," including pipe, fork, lamp, and spoon, can now be had for less than five dollars. This affords a chance for those who have acquired the habit to follow their desires in private, without having to reveal their secret to any one. How largely this is practiced I do not know, but, judging from the tell-tale pallor of the faces I see, I feel sure the habit is claiming more slaves every day.

In order to approximate to the amount of opium in its various forms which is used in Boston, I have made a thorough scrutiny of the physicians' recipes left at the drug-stores to be filled. As is well known, all recipes given by physicians are numbered, dated, and kept on file at the drug-stores, so that they may be referred to at any time. To these I went in search of information.

I was surprised to learn how extensively opium and its alkaloids—particularly sulphate of morphia—are used by physicians. I found them prescribed for every ailment which flesh is heir to. They are used for headache, sore eyes, toothache, sore throat,

laryngitis, diphtheria, bronchitis, congestion, pneumonia, consumption, gastritis, liver-complaint, stone in the gall-duct, carditis, aneurism, hypertrophy, peritonitis, calculus, kidney trouble, rheumatism, neuralgia, and all general or special maladies of the body. It is the great panacea and cure-all.

During my leisure time I have looked up more than 10,000 recipes. It has been my practice to go to the files, open the book, or take up a spindle at random, and take 300 recipes just as they come. The first store I visited I found 42 recipes which contained morphine out of the 300 examined. Close by, a smaller store, patronized by poorer people, had 36. Up in the aristocratic quarters, where the customers call in carriages, I found 49 morphine recipes in looking over 300. At the North End, among the poor Italian laborers, the lowest proportion of 32 in 300 was discovered. Without detailing all the places visited, I will summarize by saying that, in 10,200 recipes taken in 34 drug-stores, I found 1,481 recipes which prescribed some preparation of opium, or an average of fourteen and one half per cent of the whole.

This was surprising enough; but my investigations did not end here. Of the prescriptions furnished by physicians I found that forty-two per cent were filled the second time, and of those refilled twenty-three per cent contained opium in some form. Again, twenty-eight per cent of all prescriptions are filled a third time; and of these, sixty-one per cent were for opiates; while of the twenty per cent taken for the fourth filling, seventy-eight per cent were for the narcotic drug, proving, beyond a doubt, that it was the opiate qualities of the medicine that afforded relief and caused the renewal.

From conversation with the druggists, I learned that the proprietary or "patent" medicines which have the largest sales were those containing opiates. One apothecary told me of an old lady who formerly came to him as often as four times a week and purchased a fifty-cent bottle of "cough-balsam." She informed him that it "quieted her nerves" and afforded rest when everything else had failed. After she had made her regular visits for over a year, he told her one day that he had sold out of the medicine required, and suggested a substitute, which was a preparation containing about the same amount of morphine. On trial, the woman found the new mixture answered every purpose of the old. The druggist then told her she had acquired the morphine-habit, and from that time on she was a constant morphine-user.

It was hard to learn just what proportion of those who began by taking medicines containing opiates became addicted to the habit. I should say, from what I learned, that the number was fully twenty-five per cent—perhaps more. The proportion of those who, having taken up the habit in earnest, left it off later on, was

very small—not over ten per cent. When a person once becomes an opium-slave, the habit usually holds through life.

I was told many stories about the injurious effects of morphine and opium upon the morals of those who use it. One peculiarity of a majority is that, whenever a confirmed user of the narcotic obtains credit at the drug-store, he at once stops trading at that place and goes elsewhere. All the druggists know this habit very well, and take pains to guard against it. Whenever a customer asks for credit for a bottle of morphine, the druggist informs him that the store never trusts any one; but if he has no money with him the druggist will gladly give him enough to last a day or two. In this way the druggist keeps his customer, whereas he would have lost his trade if the present had not been made at the time credit was refused.

Of course, I heard much about the irresistible desire which confirmed slaves to the habit have for their delight. There is nothing too degrading for them to do in order to obtain the narcotic. Many druggists firmly believe that a majority of the seemingly motiveless crimes which are perpetrated by reputable people are due to this habit. In pursuit of opium the slaves will resort to every trick and art which human ingenuity can invent. There is a prisoner now confined in the Concord (Mass.) Reformatory who has his opium smuggled in to him in the shape of English walnuts donated by a friend. The friend buys the opium and, opening the walnut-shells, extracts the meat, and fills up the spaces with the gum. Then he sticks the shells together with glue and sends them to the prison.

At present our clergymen, physicians, and reformers are asking for more stringent laws against the sale of these narcotics. The law compelling every person who purchases opium or other poisons to "register," giving his name and place of residence to the druggist, has been in force in Massachusetts for several years, and all this time the sales have increased. No registration law can control the traffic.

The parties who are responsible for the increase of the habit are the physicians who give the prescriptions. In these days of great mental strain, when men take their business home with them and think of it from waking to sleeping, the nerves are the first to feel the effects of overwork. 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.

Two means of preventing the spread of the habit suggest themselves to every thoughtful person:

1. Pass a law that no prescriptions containing opium or its preparations can be filled more than once at the druggist's without having the physician renew it. The extra cost of calling on a doctor when the medicine ran out would deter many poor people from acquiring the habit. Such a law would also make the doctors more guarded in prescribing opiates for trivial ailments. With the law in force, and the druggists guarded by strict registration laws, we could soon trace the responsibility to its proper source, and then, if these safeguards were not enough, physicians could be fined for administering opiates save in exceptional cases.

2. The great preventive to the habit is to keep the body in such a state that it will not require sedatives or stimulants. The young men and women in our cities have too big heads, too small necks, and too flabby muscles. They should forsake medicine, and patronize the gymnasium. Let them develop their muscles and rest their nerves, and the family doctor, who means well, but who can not resist the tendency of the age, can take a protracted vacation. Unless something of the kind is done soon, the residents of our American cities will be all opium-slaves.

STIGMATIZATION.

By Rev. RICHARD WHEATLEY.

THE stigmata—what are they? Wounds resembling those received by the Lord Jesus Christ at his crucifixion. When fully developed they consist of one in the palm of each hand, one on the dorsum of each foot, each indicating the place where a nail was driven in the act of nailing Christ to the cross, and one on the side, showing the effect of the Roman soldier's spear-thrust. Sometimes, in addition to these, there are signs upon the forehead, corresponding to the lacerations caused by the thorns. Stigmatization is the technical ecclesiastical term for the formation of such resemblances.

Görres acknowledges that in all Christian antiquity no known examples of stigmatization occurred. They are peculiar to the later eras of Christian history. Roman Catholicism has usually enumerated about eighty instances, but in 1873 Dr. Imbert Gourbeyre, professor in the School of Medicine of Clermont-Ferrand, in Belgium, and a writer attached to that religious system, enlarged the series so that it now comprehends one hundred and fifty-three cases, of which eight are living and known to him. Of all these instances that of Francis Bernadone, canonized as St. Francis d' Assisi, in Italy, is the first and most commanding. Born in 1186 and dying October 4, 1226, he is said to have received the stig-

mata in 1224. In the solitude of Monte Alverno, a part of the Apennines bestowed on him by Count Orlando, of Cortona, and a favorite place of retirement, he thrice opened the Scriptures where they detail the passion of the Lord. This was interpreted to mean that in some way he was to be brought into mysterious conformity with the death of the Redeemer. While praying, he experienced a most passionate desire to be crucified with Christ, and saw, or imagined he saw, a seraph with six wings; two were arched over the head, two veiled the body, and two were stretched for flight. Amid these wings appeared the likeness of the Crucified. Joy filled the soul of Francis, but grief also pierced his heart like a sword. The vision vanished, but left him in an indescribable condition of delight and awe. His body, like wax exhibiting the impression of the seal, now showed the stigmata. Each hand and foot was pierced in the middle by a nail. The heads of the nails, round and black like nails of iron, were on the palms of the hands and fore part of the feet. The points of the nails, which appeared on the other side, were bent backward on the wounds they had made. Though somewhat movable, they could not be drawn out. St. Clare tried, but failed, to do it after his death. From a deep-red wound of three fingers' breadth in his left side, as if he had been pierced by a lance, the sacred blood then and frequently afterward flowed upon his tunic. These wounds never gangrened nor suppurated, nor did he try to heal them. Hands and feet could be used as aforetime, but walking became so difficult that on subsequent journeys he usually rode on horseback. Countless miracles were ascribed to these wounds. Fifty Franciscan brethren declared that they had seen them at one and the same time. Pope Alexander IV publicly affirmed that he too had seen them with his own eyes.

Christine de Stumbele, born near Cologne in 1242, and a hysterical, epileptic, and erotic woman, not only bore the five wounds on Good-Friday, but also the crown of thorns on Tuesday of Passion Week, and the bloody sweat on Holy Thursday. The details of her experiences, as given by Dr. William A. Hammond in his work on "Nervous Derangement," are what the English would call decidedly "nasty." Besides, she avowed possession and torment by a devil, which is not at all unlikely, in view of her filthy and degraded habits. Yet she is now honored as a saint by the majority of the Roman Catholic Church in that section of Europe.

Veronica Giuliani, a capuchin nun who died at Città di Castello in 1727, in an ecstasy prayed that she might be crucified with her Saviour, and saw five brilliant flaming rays issue from his wounds. Four represented the nails, and the fifth the lance. Heart, hands, and feet were simultaneously pierced, water and

blood flowed from the side, great pain was suffered, and she also "felt herself transformed into our Lord." Her stigmata were accepted as genuine gifts of God by the Inquisition, Pope Pius VII beatified her, and Gregory XVI canonized her on the 26th of May, 1839.

Anna Catharine Emmerich, a nun of Dülmen, after long previous illness, experienced full stigmatization in 1811, was repeatedly examined by the authorities, endured great pain, and always emitted blood on Fridays. The same thing is affirmed of Maria von Mörl, at Kaltern, in southern Tyrol, who after illness received the stigmata in 1833. More than forty thousand visitors went to see them. Maria Domenica Lazzari, of Capriani, is said to have borne the marks of Christ's passion on her forehead, hands, feet, and side from 1834 until 1850, and to have felt from them the most terrible physical pain.

Palma d' Oria, an Italian woman of sixty-six, visited by Dr. Imbert Gourbeyre in 1871, is or was confessedly another diabolically tormented, angelically visited individual, and was also an expert *prestidigitateuse* whose performances were too blasphemous and shocking to be used for purposes of scientific information. Her stigmata left no scars to indicate the places whence the blood had flowed. She insisted that she had not eaten anything for seven years, but had been obliged to drink a great deal because of the fierce internal heat which consumed her. This was so intense that the water swallowed was ejected at boiling temperature.

The latest and most celebrated instance of stigmatization is Louise Lateau, born in the deepest poverty at Bois d'Haine, Belgium, January 30, 1850. Chlorotic, unhealthy, and hysterical from childhood, subject to visions of saints and the Holy Virgin, and wont when in ecstasy to utter very edifying things of poverty, charity, and the priesthood, her stigmatizations have occurred after passing through her paroxysms. On Fridays she bled from the left side of her chest, blood escaped from the dorsal surfaces of both feet, and from the dorsal and palmar surfaces of both hands. Finally, other points of exit appeared in the forehead and between the shoulders. In her seizures she was insensible to all external impressions, and acted the passion of Jesus and the crucifixion. She also declared that she did not sleep, had not eaten or drunk for four years, and that the ordinary excretory processes of the body had been wholly suppressed.

America, of course, can not be excluded from the list of the lands of wonders. Fortunately, it presents but one example of the stigmatized. This is said to be Vitaline Gagnon, in the diocese of Quebec, a young woman whose early piety was demonstrated by the repetition of *Ave Marias* among the tombs, and who loved the souls in purgatory so much that they often made themselves vis-

ible to ask for the benefit of her prayers. On making her profession as a member of the *Sœurs Grises* at Ottawa she received the stigmata. Since then she had bled every Friday, suffered terribly, taken no nourishment, exhaled perfumes from her wounds, offered all her sufferings for souls in purgatory, is stout of body, and shows signs of perfect health.

Are the stigmata miraculous, or may they be accounted for on pathological principles? Two answers are given to this question. The first is purely theological, or rather ecclesiastical; the second is purely scientific. Mediæval ecclesiasticism affirms them to be miraculous; science maintains that they are natural. Roman Catholicism holds them to be miraculous, but does not make it an article of faith that all its adherents must believe. The Franciscan friars. and also the majority of Roman Catholics, fervently believed and stoutly insisted that the stigmatization of Francis Bernardone was miraculous. Dean Milman says that this almost became the creed of Christendom. "The declaration of Pope Alexander, the ardent protector of the mendicant friars, imposed it almost as an article of the belief." Nicholas IV, who was himself a Franciscan, asserted the stigmata of St. Francis; a papal bull in 1255 vindicated the claims of the miracle; and Pope Benedict XI set apart the 17th of September of each year as the feast of the Holy Stigmata. The Dominicans, irreconcilable rivals of the Franciscans, represented the whole affair as an imposture invented to raise the credit of their competitors for papal and popular favor. The Bishop of Olmutz denounced the alleged miracle as irrational. The Dominican, Jacob de Voragine, did not deny the fact of the stigmata, but assigned five causes for them. All resolve themselves into the first, which is imagination. Petrarch, Cornelius Agrippa, etc., attributed the stigmatization of Bernardone to his glowing fancy, or to an excited imagination acting on a body enfeebled by sickness and religious mortifications.

As for Palma d'Oria, after reading Dr. Hammond's relation of her absurd impostures, it is difficult not to conclude with him that she was syphilitic, strongly hysterical, the subject of *purpura hæmorrhagica*, and "a most unmitigated humbug and liar."

Neander adopts the theory of Voragine, and thinks that the story of the stigmata of Francis of Assisi sprang "from the self-deception of a fanatical bent of the imagination, and from fancied exaggeration." His language is that of the true philosophic scientist. The phenomena, whatever they were, in the case of St. Francis should be studied in the light of his character. As a youth he was vain, gay, and prodigal; of ethical education so neglected and perverse that after his reformation he did not scruple to steal from his father in order that he might repair the dilapidated church of St. Damian. Regarded alike by his neighbors and by

Innocent III as a madman, and undoubtedly half-crazy and fanatical, he pretended to the gifts of prophecy and miracles. Beggar and nurse of lepers, pious and beneficent, he was still so deficient in moral sense as to set filial duty and parental authority at defiance, and to lure three imaginative sisters of rank and fortune into a life similar to his own. Ascetic, unnatural, and a devotee, he approached so near to utter insanity that the Mohammedan Sultan of Egypt, whom he essayed to convert to his Christianity, was fully warranted in tenderly dismissing him as a lunatic. Blameless, gentle, loving, and fondly pantheistic in sentiment, his energies were wholly consecrated to the support of the endangered papacy, and the establishment of its claims against all dissenters. Such a miracle as that he affirmed would, in a grossly superstitious age, be a patent aid to him in his work. Great good and no small evil were blended in one and the same man; good that voiced itself in many memorable sayings, and induced him to conceal what he himself seems to have doubted—the marks on his hands by covering them with his habit, and on his feet by wearing shoes and stockings. There is no known limit to human credulity, and particularly in an age so illiterate and unscientific. The ecclesiastics had an adequate motive in their claim to complete dominance over the human race for bolstering up his pretensions, and for elevating the abnormal experiences of a kindly monomaniac to the rank of a miracle. Not less powerful is the motive that Belgian ecclesiastics have for upholding the claims of Louise Lateau, whose personal reward is in notoriety, rich presents, and the lavish praises of wily or superstitious advisers.

Modern medical science asserts the naturalness of the stigmata. In harmony with Neander's suggestion, it looks upon the story of St. Francis, of Lateau, and of others, as one "with regard to which it still needs and deserves inquiry to what extent, in certain eccentric states of the system, a markedly overexcited fancy might react on the bodily organism." The closest attention has been paid to Louise Lateau. M. Warlomont, commissioned by the Royal Academy of Medicine of Belgium to examine her, accompanied by several friends, made a careful examination of her person. The subject went through her regular programme. At six o'clock on Friday morning blood was freely flowing from all the stigmata. Then, as also at other times, there was no apparent external excitation of the hæmorrhage. The blood effused was of normal character, excepting the excessive amount of white corpuscles. So far, all seemed to be genuine. She did, however, when closely questioned, confess to short periods of forgetfulness at night. A cupboard in her room contained bread and fruit, and her chamber communicated directly with the yard at the back of the house. M. Warlomont concluded that the ecstasies and stig-

matizations were real, and that she ate, drank, slept, etc., like other mortals. Closely watched and deprived of food as the poor little fasting Welsh girl, Sarah Jacob, was, she would as certainly die. Even Dr. Tanner could not indefinitely resist so great a drain on vital force. Outraged nature would put further maltreatment beyond power of infliction.

Dr. D. H. Tuke, in his "Influence of the Mind upon the Body," adduces numerous instances of the fact that intense sympathetic attention to the physical injuries or pains of another produces similar phenomena and experiences in the sympathizer. Medical men show the connection between skin-diseases and nervous derangement. *Urticaria*, or hives, in children is the effect of emotional disturbance. In the disease known as *purpura hæmorrhagica*, Dr. Hammond states that "the blood is deficient in red corpuscles, while there is an increase in the white globules. . . . The affection is further characterized by a tendency of the blood to transude through the coats of the vessels." Boerhaave relates the case of a young girl who had *ampullæ*, or dilatations resembling little jugs, on various parts of her body, from which the blood flowed copiously, and which then, like those of Palma d' Oria, closed up without leaving any trace. Similar examples, more or less striking, are well known to dermatologists. From these deposits of blood in weakened, hysterical subjects, hæmorrhages follow closely on the occurrence of strong emotion. Thus Francis of Assisi, Louise Lateau, and others, thoroughly excited by passionate devotion and desire to exhibit the stigmata—where such exhibition has been the dominant idea, and the momentary expectation of its outbreak has been entertained—have unconsciously so directed the currents of nervous energy that the very phenomena desiderated have become visible. There may not have been anything but a remote correspondence between these phenomena and the wounds of the Redeemer, but extravagant fancy would at once ignore the discrepancy. Superstition always believes what it wants to believe, and the common experience of humanity is that each individual can usually behold what he desires to see. Deceivableness is one of the qualities of the human race. Dr. Hammond quotes as the counterpart of the so-called miraculous instances of the stigmata from Dr. Magnus Huss, of Stockholm, Sweden, as cited by M. Bourneville, the case of Maria K——, a servant-girl, aged twenty-three, from whose skin the blood oozed in various places after emotional disturbance. "When the exuding surface was examined with a lens, no trace of excoriation of the skin was discovered. . . . The most careful inspection failed to show any sign of a cicatrix." She naturally became the object of great curiosity, and, finding that she could cause the phenomena to take place at will, frequently produced the hæmorrhage desired

by seeking the excitement of a quarrel with some other patient. Without such assistance, she could also, by the mere effort of will, produce the mental condition from which the bleeding resulted. There is an "absolute identity in all essential respects of the cases of Maria K—— and Louise Lateau," and, it may be added, of Francis Bernardone and all other stigmatists. Many other instances like that of Maria K—— are mentioned by dermatologists.

The stigmata are worthless except as proving the influence of the mind over the body, and in this influence the power of thought, affection, and will upon its nutrition, force, and availability for service, or the contrary. They prove nothing in favor of Christianity as divine, nor of the superiority of one form of Christianity over another, or over any system of religion and ethics. They unquestionably prove nothing in favor of the moral excellence of the subjects, and certainly not that the stigmata of Francis were, as the popes declared, "the special and wonderful favor vouchsafed to him in Christ." He was not, even in later years, an ideally good man; Lateau is not of the loftiest character; Palma and the Stumbele woman were vile, and the Swedish girl utterly unscrupulous. The stigmata are useful, if useful at all, simply because they furnish material for scientific investigation, and because they warn against the dangerous material and moral conditions under which such abnormal phenomena become possible. The "Liber Conformitatum" and many other volumes exemplify the tendencies of ignorant superstition. Francis was exalted above Christ. His worship in prayer and in picture vied with that of the Redeemer. Indignant reaction from the degrading absurdity was attended by the bitterest satire and the rudest burlesque, and wrought fearful damage alike to reason, religion, and good morals.

Truth is only for those who supremely desire it. Belief, if not faith, is largely a matter of inheritance, of education, of circumstance, of preference, of will. In the debate which followed the presentation of M. Warlomont's report to the Royal Academy of Medicine of Belgium on the subject of Louise Lateau, the opinions of the speakers were in agreement with their predilections. "M. Lefebvre held to his view of miracle in the case, and M. Crocq declared that it did not pass beyond the category of pathological occurrences." Finally, the Academy decided to have nothing more to do with the matter.

CONCERNING the relative value of classical and modern language studies, Prof. Seeley thinks that much depends on how far the classical method is pursued, whether it be first rate or not. For persons intended for an early apprenticeship to active life and business, a good knowledge of English and of modern languages may be made a much more effective instrument of culture than the very bad knowledge of Latin and Greek which is all that they usually acquire.

HELIOTROPISM: THE TURNING MOTIONS OF PLANTS.

By CONWAY McMILLAN.

AS its derivation would indicate, heliotropism means "turning toward the sun," and is the technical name applied to all such phenomena in the vegetable kingdom. It was well known to the ancients that plants exhibited a remarkable sensitiveness to light, for Aristotle mentions it, and indeed, in its more apparent forms, it is conspicuous even to the *naïve* observer of to-day. The sunflower, or *tournesol*, as the French name it, follows the daily course of the sun with its disk-like inflorescence; plants, potted and placed in a window, bend toward the light, unless, perchance, the plant is an ivy, in which case it bends away from the source of illumination; trees and shrubs in the edge of a thicket or forest may be seen to slant toward the open, and in general it may be said that there is scarely a plant which does not respond more or less distinctly to the directive action of light. Exceptions, as shown by Darwin and by Edouard Morren in his treatise on insectivorous plants, are for the most part carnivorous species like *Dionea*, *Drosera*, and *Nepenthes*—the Venus's-flytrap, sundew, and pitcher-plant, respectively—and twining plants. The reason why these plants should not fall under the rule will be apparent when the uses of heliotropism are discussed. Parasitic and the so-called saprophytic plants of the lower orders—those which live upon once-living matter—are commonly insensible to heliotropic stimulus, and, in short, all plants devoid of the great light-product—chlorophyl—manifest in this direction either weak irritability or none at all.

Heliotropism, it must be remembered, is not confined to plants as individuals, but is manifested by the different organs in varying degrees. Tendrils, for example, are either distinctly heliotropic, or far more commonly apheliotropic, as Darwin calls it—that is, negatively heliotropic; leaves are transversely or diaheliotropic—in other words, they tend to place themselves perpendicularly to the incident rays; stems, flower-peduncles, even roots, each in its own way, reply to the stimulus of lateral light. In passing, it should be mentioned that a plant has but one way of responding to conditions without, and this is by curvature. Even the sleep of leaves, the spontaneous movements of the sensitive-plant, or of that singular pulse, the *Hedysarum gyrans*, in which the two lateral leaflets keep up an incessant jerking motion; the reaction to a cut, bruise, or wound of any kind—as may be seen in an injured tendril; the effect of ether or chloroform, and indeed of natural forces such as electricity, gravity, or heat-vibrations, is in every

case a modified curvature. This is the one way which a plant has of reacting to the external world. Motile organisms, as, for instance, the microscopic swarm-spores of *Hæmatococcus* or *Botrydium*—a couple of fresh-water algæ—may seem to stretch the strict interpretation; but their movements may be considered under the law if one remembers that they are free, solitary cells, and must act accordingly.

Twining plants are, perhaps, the most interesting examples of an-heliotropic irritability, for their habit of growth—by no means leaving the instinctive circumnutation of the tip out of account—is a manifestation of insensibility to light. The morning-glory is a perfect example. Regardless of the sun, it twines regularly along its support, never for a moment being deflected or turned aside through conditions of unequal illumination. Of the same thing the wistaria is an equally instructive illustration. It may be safely presumed that, originally, twining plants were not twining plants at all, but were creeping in their habits; and from this it seems probable that heliotropism was once present, but is now lost. In its first appearance the habit of twining must have been accidental, and just how heliotropic tendencies were overcome by the newly developed trait is difficult to explain. It is interesting to notice, however, that the shoot of the morning-glory, when it first peeps from the ground, is distinctly heliotropic, and this must be considered an embryonic feature significant precisely as the branchial development of the fœtal mammal is significant—that is, there is indicated by it a line of descent.

A distinction must first be made between the periodic movements of leaves and stems and the true heliotropic movements. As pointed out by Dr. Julius Sachs, the first—such as the well-known phenomenon of sleep—are dependent upon the intensity of illumination, while the second are almost entirely due to the direction from which the rays chance to be falling upon the plant. It will be indispensable to a clear comprehension of what true heliotropism is to speak somewhat generally of light-action in vegetable physiology.

There is certainly no more important agent in the whole system of Nature than light. It is only in light that green plants can form their chlorophyl, and, since this chlorophyl is absolutely essential in the assimilating processes, its importance can be conceived. Even chlorophylless plants—the fungi and slime-molds—and all animals are indirectly dependent, as is well known, upon the possibility of chlorophyl-formation. The whole organized world, then, depends upon light as one of its essentials, for undulations of the ether are necessary to the well-being of all protoplasm. But not only does protoplasm react to these undulations, in very many instances, by the elaboration from itself of the

obscure carbon compound we call chlorophyl—it also manifests what is named *irritability*. This irritability is a property of all living things, and is what distinguishes them from lifeless things. It is the one great difference between a monad and a crystal. Not only in the presence of light is irritability manifested by a living creature, but also when the influence of any other natural force is felt. It is, however, only with light that we have to do at present.

Perhaps, in the whole field of biological science there is not a more obscure subject than this very one of protoplasmic irritability. Dutrochet follows the older botanists when heliotropism is presented for his consideration, and attributes the whole phenomenon to the creative intelligence behind the organism. Now Hartmann, the great German pessimist, following in the footsteps of his master, Arthur Schopenhauer, attributes the twining of the wistaria and the bending away from light of the ivy-shoot to an unconscious will in nature; and teleologists like Paley or Martineau would make the whole field a basis for argument. To be compelled to call upon the first cause for what unquestionably lies within the domain of secondary causes is, of course, no less or more than a confession of ignorance, and one which the modern worker in science is always undesirous of making. Without forgetting that Newton showed himself both a great scientist and a great philosopher when he spoke of himself as but an explorer of the sea-shore while an ocean of undiscovered truth lay beyond, it seems certain that some scientific knowledge of irritability is possible. As Sachs defines it, "it is the mode of reaction to stimuli which is peculiar to living organisms." It is what Herbert Spencer had in mind when he defined life as a continual adjustment between internal and external relations; it is what Brooks has in mind when he calls life "education," and what Haeckel calls attention to when he describes life as "memory." Irritability is really, it would seem, little more than a tendency to abandon an unstable for a stable equilibrium, and may be compared to the tendency to fall which a complicated structure of blocks, for instance, will exhibit upon the slightest disarrangement of any of its components. While the manifestations of irritability are by no means conditioned upon protoplasm alone, they always have their origin in this compound. Mechanical structures of cell-wall and cell-contents act their part in modifying, transmitting, or translating the original impulse; but this impulse itself is a characteristic of protoplasm. Sachs compares the state of things in a plant-cell, before stimulus is applied, to the state of things in a locomotive upon the throttle-valve of which the engineer's hand is placed. A slight expenditure of force will set in motion a vast quantity of matter and may liberate a totally disproportionate amount of energy.

This is evidently—in the plant-cell just as in the engine—because things are in the condition to react to slight stimulus. Thus, when a ray of light falls upon a motile swarm-spore, and it swims toward the illuminated side of the drop of water in which it is confined, the undulations of the ether may be held to have caused a more or less continuous change in the molecular structure of the protoplasm; energy is liberated, and ciliary motion in a certain direction is the final resultant. In the same way, when the sun rises in the morning, rays fall upon the stems of the sunflowers, intimate structural changes take place in the cell-protoplasm, and, through mechanical contrivances which will be mentioned later, a slow curving toward the light is effected.

This remarkable instability of protoplasm—and the writer craves the privilege of considering it only as a chemical compound of astonishing complexity—is of deep interest when considered in its relation to *growth.* Upon this something must be said. The growing part of a plant is, as we know, only the living part. Heart-wood is always dead wood, and is incapable of reacting to the external world except as unorganized matter might. Furthermore—and this need scarcely be mentioned, since the rudiments of botanical knowledge have become so wide-spread—the whole mass of living, growing tissue is made up of cells more or less crowded together, more or less individual in their forms and functions, but all of the same general plan of structure. If one could imagine the Capitol-dome at Washington completely filled with a densely crowded mass of toy balloons, each balloon distended with water, and containing within the water, usually surrounding most of it, a sac-like piece of sponge, it will be a fair idea of what a growing-point would be like if seen upon a sufficiently large scale. The phrase "growing-point" will be understood to have the technical significance, meaning the extreme tip or apical area of a bud or shoot. Each cell-wall contains its cell-sap, or cell-fluid, and its cell-protoplasm, which was compared to the sponges. The protoplasm is, of course, the only essential living part, and the others are but elaborations and mechanisms by which the complicated cell-life, as part of an organic whole, is possible. Or the appearance of a growing-point might be compared to the mound of small bubbles which may be blown in a bottle half filled with suds. Hundreds of bubbles, each full to bursting of air, press each other in every direction, and constitute a more or less conical and coherent mass of bubbles. It is here that the important point is to be noticed—

Growth is possible only when the cells are in a state of tension.

As one may easily discover, a flabby leaf will not increase in size, and a limp and flaccid stem is equally incapable of growth. In other words, growth of a plant-cell is like the growth of a bal-

loon at the gas-works. No increase in size is possible without increase of the internal pressure. Turgescence, as the state of tension is called in plant physiology, depends upon the amount of liquid in the cells, and may be regulated by the protoplasm. Indeed, a leaf may be strangled as readily as an animal which is taken by the throat. If one ties a string tightly around the petiole, water evaporates from the blade, and can not be supplied from below in sufficient quantities to keep the cells tense and elastic. Consequently, the whole leaf relapses into a state of flabbiness, and growth is impossible. Remembering, then, that growth of cells, and consequently of cell-tissue, is an unheard-of thing without turgescence, hydrostatic pressure, or, in a word, *stretching*, let us see what effect light has upon the condition of things within the plant-cell.

Although experiments along these lines are difficult to make, and, when made, difficult to interpret, it is the opinion of most botanists that the effect of light upon growth is one of retardation rather than of acceleration. It is true that plants will not thrive in darkness, but that is due to cessation in the assimilating processes. This is a comparatively clear case, and may be tested by experiment. Let a potato-tuber be cut in halves, each half containing one or more buds, or "eyes," and then let one half be allowed to sprout in darkness, while the other is brightly illuminated. Conditions of temperature and moisture should be precisely the same in each case. What, then, will be the result? Simply this: After a certain period, the length of which may vary from a day or two to more than a week, each half of the tuber will sprout, put forth a shoot, and upon this shoot there will be developed leaves. The two shoots will, however, be unlike. The one grown in light, or under normal conditions, will be short, plump, firm, green in color, and will bear well-developed green leaves. The shoot grown in the dark—the etiolated shoot, as it is technically named—will be long and slender, the leaves will be smaller, and in neither leaves nor shoot will there be a healthful green color. In other words, light seems to contribute to the production of a shorter shoot, and darkness to a longer. As to the growth of leaves, which are the assimilating organs of the plant, it is natural to suppose that in darkness they would be smaller; and such, in fact, is shown to be the case by the experiment with the potato. Having less to do, and less to do with, than leaves grown under normal conditions, they are correspondingly smaller and weaker. Microscopic examination of the two shoots will show furthermore that the fundamental tissue-cells in the etiolated shoot are much thinner-walled than in the normal shoot. In brief, the cells are *stretched* more tightly by the contained protoplasm when free from light than they are when exposed to its influence.

Perhaps these phenomena of growth-retardation in light are partly the result of dispersion of energy. In light there is heliotropism with other forms of irritability, chlorophyl-making, assimilation, and growth; while in darkness there is but response to the influence of gravity and growth. Buds which contain a definite amount of stored-up energy will, perhaps, bring to pass different results, as the number of uses made of this energy may vary. Nature is constantly performing experiments along these lines which indicate such a probability. The alternation of day and night presents a natural periodic etiolation of most normally situated plants. Examination will show that growth is more rapid in darkness than in light, and in many plants it is only at night that any considerable increase of size takes place. Some plants, like the hop—which chances to be apheliotropic—do not grow more rapidly in darkness, and this may be attributed to a difference in irritability, or perhaps an inhibition of the growth process by some other. At night, however, the temperature is lower than in the daytime, and this is inimical to growth. Again, some flowers open only at night, and since the opening of a flower is evidence that growth is retarded, another apparently abnormal case is offered. Such instances are unusual and poorly understood. In general, darkness seems to favor a maximum of turgescence in plant-cells.

Motion, now, in plants is a phenomenon of growth—not, very possibly, of growth, viewing the plant as a whole, but considering the cells separately. The sunflower turns to the sun because, upon the side next the source of illumination, the cells possess a kind of irritability, in view of which, through molecular changes in the irritated protoplasm—making it more absorbent—growth is retarded and curvature ensues. The old theory of De Candolle differed from this in that light was supposed to be inimical to nutrition, or cell-formation, and the meaning of turgescence and of irritability was not clearly understood. The ivy, which turns away from the sun, may possibly be accredited with a different kind of irritability, or, what seems more reasonable, habit may act as an inhibitor.

With regard to simple cells, the terms of the law that heliotropism is a phenomenon of growth must be modified a little. The *Bacterium photometricum* of Engelmann, which moves only under the influence of light, does not at the same time increase in size. Neither do the filaments of the *Oscillaria* nor the zoöspores of algæ. The plasmodia of slime-molds, which, except during the spore-forming stage, are negatively heliotropic, do not grow while turning from the light. Irritability in these organisms is translated at once into ciliary or mass movement, and has to do with growth only in a secondary way. It is, however, clearly

analogous in the molecular changes, and need not be considered apart. The mechanism is different, though the forces are the same; just as steam is the same, whether it runs a rolling-mill or a locomotive.

The chemical or molecular theory of light-action is greatly strengthened by two considerations: The first is, that a latent period, after stimulus and before reply, can be detected in almost every case. This, as evidence of chemical action, is conclusive. Second, the researches of Wiesner, and especially those of C. M. Guillemin, recorded in the "Annales des Sciences Naturelles," series iv, vol. vii, in which careful investigations are made into the kind of light which has the greatest effect in heliotropism, must be noted. With regard to assimilation—as we should indeed expect—the yellow rays are found to be the most favorable; but when light is studied with reference to irritability, the results are entirely different. The maxima of action are now found to be at the extreme ends of the spectrum; the ultra-red and the ultra-violet or so-called actinic rays seem to be the ones best capable of giving the necessary stimulus. The minimum is found to be in the blue, near the "F" line. That this "division of labor," as it were, among the light-rays, should be so evident and so constant, offers strong testimony in favor of the theory that irritability and assimilation are equally molecular in their nature (if we may use such an expression), and the whole hypothesis seems unusually clear and satisfactory.

To return for a moment, now, to the potato-shoot grown in darkness, one other peculiarity besides those mentioned might have been noticed. That was this: the angle between leaves and leaf-axis, or stem, was always more acute than in the normally grown plant. The whole etiolated shoot seemed to be straining toward the light. Kraus believed that this was due to imperfect anatomical development in the fibro-vascular bundles; but such a view is scarcely confirmed by the facts, for etiolation is concerned not with the fibrous system alone, but with the fundamental. Rauwenhoff supposed the vertical position of shoots grown in darkness attributable to absence of heliotropism, and the consequent unmodified action of another force in plant-physiology, namely, negative geotropism, or, more clearly, "negative gravity." This is a kind of irritability, in view of which plant-shoots tend to increase in length in a direction opposite to the terrestrial attraction. This, he thought, might be favored by the feeble thickening of the cellular tissues. In this Sachs is inclined to support Rauwenhoff; but it seems probable that the whole matter will have to be laid at the door of heredity. The plant which has always struggled upward to the light will continue to do so when placed in darkness, and all its efforts will be concentrated upon

this one end. Leaf-formation will be scanty; assimilation will be suspended; and the whole organism will reach out for the sunlight, as thousands of generations had done before its own life. That fungi of the mushroom type—needing no light, for they make no chlorophyl—reach upward too—and it is undeniably true that they elongate more rapidly in darkness—is to be considered as evidence of descent from an alga stock, and this is rendered probable by morphological as well as by this interesting physiological consideration. Heredity may come into play here as well as it does in the case of the moss antherozoids, which are attracted by the archegonium, or in the case of the fish-mold zoöspores, which swim toward decaying fish or putrid extracts of meat.

From all this, the meaning of heliotropism in the natural order of things becomes apparent. The phenomena which have been studied fit into the evolution theory as if made for the theory and not the theory for them. Plants which must have light to live are impelled toward this light by their own conditions of structure. The reaching upward is sometimes almost instinctive—almost conscious, one might fancy. Knight observed a vine-leaf try first one way and then another to reach the position of best illumination—a transverse one, which is now considered to be a result of the palisade structure, and not of a peculiar kind of irritability. Dutrochet noticed the tendril of a pea trying to avoid the light, and it finally seemed to send an impulse down to the petiole, and *this* bent backward. The question of resistance is probably, however, the only one which needs to be considered as modifying plant-action in such instances.

Climbing and twining plants, as Darwin observed, have lost their heliotropism because they would be pulled away from their supports if they always followed the sun. For the same reason tendrils, aërial roots, the suckers of *Parthenocissus quinquefolia*—the Virginia creeper—are, considered as separate organs, apheliotropic rather than the reverse. Carnivorous plants, which at least partially depend for sustenance upon a peculiar position of leaves and stem, and which have less need of light for assimilation, have also lost their powers of response to the heliotropic stimulus. It must not be supposed, however, for a moment, that heliotropic irritability is not present. It may be there, and well developed too; but inhibited by heredity, by growth, by environment. Just as the compass-plant when grown in darkness allows its leaves to adopt the horizontal position, so does the Venus's-flytrap when growing normally, and it is probable that, if generation after generation of compass-plants could be grown in the darkness, the erect position of the leaves would permanently disappear. Just so the Venus's-flytrap has lost the power of responding to its heliotropic tendency, through its carnivorous habits. Vines, indeed, thinks

a different kind of irritability, or at least a conspicuous lack of the normal kind, is denoted by such habits of growth; but gravity, heredity, and anatomical peculiarities may be entirely responsible. Nor need the meaning of heliotropism in a theory of descent be seriously affected by the observations of Sachs upon certain roots which, although never normally in the light, showed marked heliotropic irritability when grown in illuminated water. In such cases a change in protoplasmic structure might easily have ensued after the change in life-conditions and before the manifestation of unexpected irritability. It is this which renders conclusions drawn from such data as Sachs had doubtful and, perhaps, fallacious.

Heliotropism, then, must be considered as a well-marked physiological trait; developed through ages of natural selection, in accordance with the laws of use and disuse, and here and there modified or altogether absent, as the needs of the organism chanced to demand. It is a result of irritability, and is usually manifested in connection with growth. As acknowledged above, it is still rather poorly understood, in its more recondite expressions; but, in general, it may justly be held to be a very complicated reaction in the department of molecular physics, or chemistry.

A FOSSIL CONTINENT.

IF an intelligent Australian colonist were suddenly to be translated backward from Collins Street, Melbourne, into the flourishing woods of the secondary geological period—say about the precise moment of time when the English chalk downs were slowly accumulating, speck by speck, on the silent floor of some long-forgotten Mediterranean—the intelligent colonist would look around him with a sweet smile of cheerful recognition, and say to himself in some surprise, "Why, this is just like Australia." The animals, the trees, the plants, the insects, would all more or less vividly remind him of those he had left behind him in his happy home of the southern seas and the nineteenth century. The sun would have moved back on the dial of ages for a few million summers or so, indefinitely (in geology we refuse to be bound by dates), and would have landed him at last, to his immense astonishment, pretty much at the exact point whence he first started.

In other words, with a few needful qualifications, to be made hereafter, Australia is, so to speak, a fossil continent, a country still in its secondary age, a surviving fragment of the primitive world of the chalk period or earlier ages. Isolated from all the remainder of the earth about the beginning of the Tertiary epoch,

long before the mammoth and the mastodon had yet dreamed of appearing upon the stage of existence, long before the first shadowy ancestor of the horse had turned tail on Nature's rough draught of the still undeveloped and unspecialized lion, long before the extinct dinotheriums and gigantic Irish elks and colossal giraffes of late Tertiary times had even begun to run their race on the broad plains of Europe and America, the Australian continent found itself at an early period of its development cut off entirely from all social intercourse with the remainder of our planet, and turned upon itself, like the German philosopher, to evolve its own plants and animals out of its own inner consciousness. The natural consequence was, that progress in Australia has been absurdly slow, and that the country as a whole has fallen most wofully behind the times in all matters pertaining to the existence of life upon its surface. Everybody knows that Australia as a whole is a very peculiar and original continent; its peculiarity, however, consists, at bottom, for the most part in the fact that it still remains at very nearly the same early point of development which Europe had attained a couple of million years ago or thereabout. "Advance, Australia," says the national motto; and, indeed, it is quite time nowadays that Australia should advance; for, so far, she has been left out of the running for some four mundane ages or so at a rough computation.

Example, says the wisdom of our ancestors, is better than precept; so perhaps, if I take a single example to start with, I shall make the principle I wish to illustrate a trifle clearer to the European comprehension. In Australia, when Cook or Van Diemen first visited it, there were no horses, cows, or sheep; no rabbits, weasels, or cats; no indigenous quadrupeds of any sort except the pouched mammals or marsupials, familiarly typified to every one of us by the mamma kangaroo in Regent's Park, who carries the baby kangaroos about with her, neatly deposited in the sac or pouch which Nature has provided for them instead of a cradle. To this rough generalization, to be sure, two special exceptions must needs be made; namely, the noble Australian black-fellow himself, and the dingo or wild dog, whose ancestors no doubt came to the country in the same ship with him, as the brown rat came to England with George I of blessed memory. But of these two solitary representatives of the later and higher Asiatic fauna "more anon"; for the present we may regard it as approximately true that aboriginal and unsophisticated Australia in the lump was wholly given over, on its first discovery, to kangaroos, phalangers, dasyures, wombats, and other quaint marsupial animals, with names as strange and clumsy as their forms.

Now, who and what are the marsupials as a family, viewed in the dry light of modern science? Well, they are simply one of

the very oldest mammalian families, and therefore, I need hardly say, in the leveling and topsy-turvy view of evolutionary biology, the least entitled to consideration or respect from rational observers. For of course in the kingdom of science the last shall be first, and the first last; it is the oldest families that are accounted the worst, while the best families mean always the newest. Now, the earliest mammals to appear on earth were creatures of distinctly marsupial type. As long ago as the time when the red marl of Devonshire and the blue lias of Lyme Regis were laid down on the bed of the muddy sea that once covered the surface of Dorset and the English Channel, a little creature like the kangaroo rats of Southern Australia lived among the plains of what is now the south of England. In the ages succeeding the deposition of the red marl, Europe seems to have been broken up into an archipelago of coral reefs and atolls; and the islands of this ancient oölitic ocean were tenanted by numbers of tiny ancestral marsupials, some of which approached in appearance the pouched anteaters of Western Australia, while others resembled rather the phalangers and wombats, or turned into excellent imitation carnivores, like our modern friend the Tasmanian devil. Up to the end of the time when the chalk deposits of Surrey, Kent, and Sussex were laid down, indeed, there is no evidence of the existence anywhere in the world of any mammals differing in type from those which now inhabit Australia. In other words, so far as regards mammalian life, the whole of the world had then already reached pretty nearly the same point of evolution that poor Australia still sticks at.

About the beginning of the Tertiary period, however, just after the chalk was all deposited, and just before the comparatively modern clays and sandstones of the London basin began to be laid down, an arm of the sea broke up the connection which once subsisted between Australia and the rest of the world, probably by a land-bridge, *via* Java, Sumatra, the Malay Peninsula, and Asia generally. "But how do you know," asks the candid inquirer, "that such a connection ever existed at all?" Simply thus, most laudable investigator—because there are large land mammals in Australia. Now, large land mammals do not swim across a broad ocean. There are none in New Zealand, none in the Azores, none in Fiji, none in Tahiti, none in Madeira, none in Teneriffe—none, in short, in any oceanic island which never at any time formed part of a great continent. How could there be, indeed? The mammals must necessarily have got there from somewhere; and whenever we find islands like Britain, or Japan, or Newfoundland, or Sicily, possessing large and abundant indigenous quadrupeds of the same general type as adjacent continents, we see at once that the island must formerly have been a mere peninsula, like

Italy or Nova Scotia at the present day. The very fact that Australia incloses a large group of biggish quadrupeds, whose congeners once inhabited Europe and America, suffices in itself to prove beyond question that uninterrupted land communication must once have existed between Australia and those distant continents.

In fact, to this day a belt of very deep sea, known as Wallace's Line, from the great naturalist who first pointed out its far-reaching zoölogical importance, separates what is called by science "the Australian province" on the southwest from "the Indo-Malayan province" to the north and east of it. This belt of deep sea divides off sharply the plants and animals of the Australian type from those of the common Indian and Burmese pattern. South of Wallace's line we now find several islands, big and small, including New Guinea, Australia, Tasmania, the Moluccas, Celebes, Timor, Amboyna, and Banda. All these lands, whose precise geographical position on the map must of course be readily remembered, in this age of school-boards and universal examination, by every pupil-teacher and every Girton girl, are now divided by minor straits of much shallower water; but they all stand on a great submarine bank, and obviously formed at one time parts of the same wide Australian continent, because the animals of Australian type are still found in every one of them. No Indian or Malayan animal, however, of the larger sort (other than birds) is to be discovered anywhere south of Wallace's Line. That narrow belt of deep sea, in short, forms an ocean barrier which has subsisted there without alteration ever since the end of the Secondary period. From that time to this, as the evidence shows us, there has never been any direct land communication between Australia and any part of the outer world beyond that narrow line of division.

Some years ago, in fact, a clever hoax took the world by surprise for a moment, under the audacious title of "Captain Lawson's Adventures in New Guinea." The gallant captain, or his unknown creator in some London lodging, pretended to have explored the Papuan jungles, and there to have met with marvelous escapes from terrible beasts of the common tropical Asiatic pattern—rhinoceroses, tigers, monkeys, and leopards. Everybody believed the new Munchausen at first, except the zoölogists. Those canny folk saw through the wicked hoax on the very first blush of it. If there were rhinoceroses in Papua, they must have got there by an overland route. If there had ever been a land-connection between New Guinea and the Malay region, then, since Australian animals range into New Guinea, Malayan animals would have ranged into Australia, and we should find Victoria and New South Wales at the present day peopled by tapirs, orang-

outangs, wild boars, deer, elephants, and squirrels, like those which now people Borneo, instead of, or side by side with, the kangaroos, wombats, and other marsupials, which, as we know, actually form the sole indigenous mammalian population of Greater Britain beneath the Southern Cross. Of course, in the end, the mysterious and tremendous Captain Lawson proved to be a myth, an airy nothing, upon whom imagination had bestowed a local habitation (in New Guinea) and a name (not to be found in the army list). Wallace's Line was saved from reproach, and the intrusive rhinoceros was banished without appeal from the soil of Papua.

After the deep belt of open sea was thus established between the bigger Australian continent and the Malayan region, however, the mammals of the great mainlands continued to develop on their own account, in accordance with the strictest Darwinian principles, among the wider plains of their own habitats. The competition there was fiercer and more general; the struggle for life was bloodier and more arduous. Hence, while the old-fashioned marsupials continued to survive and to evolve slowly along their own lines in their own restricted southern world, their collateral descendants in Europe, and Asia, and America, or elsewhere, went on progressing into far higher, stronger, and better adapted forms—the great central mammalian fauna. In place of the petty phalangers and pouched ant-eaters of the oölitic period, our tertiary strata in the larger continents show us a rapid and extraordinary development of the mammalian race into monstrous creatures, some of them now quite extinct, and some still holding their own undisturbed in India, Africa, and the American prairies. The paleotherium and the dinoceras, the mastodon and the mammoth, the huge giraffes and antelopes of sunnier times, succeed to the ancestral kangaroos and wombats of the Secondary strata. Slowly the horses grow more horse-like, the shadowy camel begins to camelize himself, the buffaloes acquire the rudiments of horns, the deer branch out by tentative steps into still more complicated and more complicated antlers. Side by side with this wonderful outgrowth of the mammalian type, in the first plasticity of its vigorous youth, the older marsupials die away one by one in the geological record before the faces of their more successful competitors; the new carnivores devour them wholesale, the new ruminants eat up their pastures, the new rodents outwit them in the modernized forests. At last the pouched creatures all disappear utterly from all the world, save only Australia, with the solitary exception of a single advanced marsupial family, the familiar opossum of plantation melodies. And the history of the opossum himself is so very singular that it almost deserves to receive the polite attention of a separate paragraph for its own proper elucidation.

For the opossums form the only members of the marsupial class now living outside Australia; and yet, what is at least equally remarkable, none of the opossums are found *per contra* in Australia itself. They are, in fact, the highest and best product of the old dying marsupial stock, specially evolved in the great continents through the fierce competition of the higher mammals then being developed on every side of them. Therefore, being later in point of time than the separation, they could no more get over to Australia than the elephants and tigers and rhinoceroses could. They are the last bid for life of the marsupial race in its hopeless struggle against its more developed mammalian cousins. In Europe and Asia the opossums lived on lustily, in spite of competition, during the whole of the Eocene period, side by side with hog-like creatures not yet perfectly piggish, with nondescript animals, half horse, half tapir, and with hornless forms of deer and antelopes, unprovided, so far, with the first rudiment of budding antlers. But in the succeeding age they seem to disappear from the Eastern continent, though in the Western, thanks to their hand-like feet, opposable thumb, and tree-haunting life, they still drag out a precarious existence in many forms from Virginia to Chili, and from Brazil to California. It is worth while to notice, too, that whereas the kangaroos and other Australian marsupials are proverbially the very stupidest of mammals, the opossums, on the contrary, are well known to those accurate observers of animal psychology, the plantation negroes, to be the very cleverest, cunningest, and slyest of American quadrupeds. In the fierce struggle for life of the crowded American lowlands, the opossum was absolutely forced to acquire a certain amount of Yankee smartness, or else to be improved off the face of the earth by the keen competition of the pouchless mammals.

Up to the day, then, when Captain Cook and Sir Joseph Banks, landing for the first time on the coast of New South Wales, saw an animal with short front limbs, huge hind legs, a monstrous tail, and a curious habit of hopping along the ground (called by the natives a kangaroo), the opossums of America were the only pouched mammals known to the European world in any part of the explored continents. Australia, severed from the rest of the earth—*penitus toto orbe divisa*—ever since the end of the secondary period, remained as yet, so to speak, in the secondary age so far as its larger life-elements were concerned, and presented to the first comers a certain vague and indefinite picture of what "the world before the flood" must have looked like. Only it was a very remote flood; an antediluvian age separated from our own not by thousands but by millions of seasons.

To this rough approximate statement, however, sundry needful qualifications must be made at the very outset. No statement is

ever quite correct until you have contradicted in minute detail about two thirds of it.

In the first place there are a good many modern elements in the indigenous population of Australia; but then they are elements of the stray and casual sort one always finds even in remote oceanic islands. They are waifs wafted by accident from other places. For example, the flora is by no means exclusively an ancient flora, for a considerable number of seeds and fruits and spores of ferns always get blown by the wind, or washed by the sea, or carried on the feet or feathers of birds, from one part of the world to another. In all these various ways, no doubt, modern plants from the Asiatic region have invaded Australia at different times, and altered to some extent the character and aspect of its original native vegetation. Nevertheless, even in the matter of its plants and trees, Australia must still be considered a very old-fashioned and stick-in-the-mud continent. The strange puzzle-monkeys, the quaint-jointed casuarinas (like horse-tails grown into big willows), and the park-like forests of blue-gum trees, with their smooth stems robbed of their outer bark, impart a marvelously antiquated and unfamiliar tone to the general appearance of Australian woodland. All these types belong by birth to classes long since extinct in the larger continents. The scrub shows no turfy greensward; grasses, which elsewhere carpet the ground, were almost unknown till introduced from Europe; in the wild lands, bushes and undershrubs of ancient aspect cover the soil, remarkable for their stiff, dry, wiry foliage, their vertically instead of horizontally flattened leaves, and their general dead blue-green or glaucous color. Altogether, the vegetation itself, though it contains a few more modern forms than the animal world, is still essentially antique in type, a strange survival from the forgotten flora of the chalk age, the oölite, and even the lias.

Again, to winged animals, such as birds and bats and flying insects, the ocean forms far less of a barrier than it does to quadrupeds, to reptiles, and to fresh-water fishes. Hence Australia has, to some extent, been invaded by later types of birds and other flying creatures, who live on there side by side with the ancient animals of the Secondary pattern. Warblers, thrushes, fly-catchers, shrikes, and crows must all be comparatively recent immigrants from the Asiatic mainland. Even in this respect, however, the Australian life-region still bears an antiquated and undeveloped aspect. Nowhere else in the world do we find those very oldest types of birds represented by the cassowaries, the emus, and the mooruk of New Britain. The extreme term in this exceedingly ancient set of creatures is given us by the wingless bird, the apteryx or kiwi of New Zealand, whose feathers nearly resemble hair, and whose grotesque appearance makes it as much a wonder

in its own class as the puzzle-monkey and the casuarina are among forest-trees. No feathered creatures so closely approach the lizard-tailed birds of the oölite or the toothed birds of the Cretaceous period as do these Australian and New Zealand emus and apteryxes. Again, while many characteristic Oriental families are quite absent, like the vultures, woodpeckers, pheasants, and bulbuls, the Australian region has many other fairly ancient birds, found nowhere else on the surface of our modern planet. Such are the so-called brush-turkeys and mound-builders, the only feathered things that never sit upon their own eggs, but allow them to be hatched after the fashion of reptiles, by the heat of the sand or of fermenting vegetable matter. The piping crows, the honey-suckers, the lyre-birds, and the more-porks are all peculiar to the Australian region. So are the wonderful and æsthetic bower-birds. Brush-tongued lories, black cockatoos, and gorgeously colored pigeons, though somewhat less antique, perhaps, in type, give a special character to the bird-life of the country. And in New Guinea, an isolated bit of the same old continent, the birds-of-paradise, found nowhere else in the whole world, seem to recall some forgotten Eden of the remote past, some golden age of Saturnian splendor. Poetry apart, into which I have dropped for a moment like Mr. Silas Wegg, the birds-of-paradise are, in fact, gorgeously dressed crows, specially adapted to forest-life in a rich fruit-bearing tropical country, where food is abundant and enemies unknown.

Last of all, a certain small number of modern mammals have passed over to Australia at various times by pure chance. They fall into two classes—the rats and mice, who doubtless got transported across on floating logs or balks of timber; and the human importations, including the dog, who came, perhaps, on their own canoes, perhaps on the wreck and *débris* of inundations. Yet even in these cases, again, Australia still maintains its proud preeminence as the most antiquated and unprogressive of continents. For the Australian black-fellow must have got there a very long time ago, indeed; he belongs to an extremely ancient human type, and strikingly recalls in his jaws and skull the Neanderthal savage and other early prehistoric races; while the woolly-headed Tasmanian, a member of a totally distinct human family, and, perhaps, the very lowest sample of humanity that has survived to modern times, must have crossed over to Tasmania even earlier still, his brethren on the mainland having, no doubt, been exterminated later on, when the stone-age Australian black-fellows first got cast ashore upon the continent inhabited by the yet more barbaric and helpless negritto race. As for the dingo, or Australian wild dog, only half domesticated by the savage natives, he represents a low ancestral dog type, half wolf and half jackal, incapa-

ble of the higher canine traits, and with a suspicious, ferocious, glaring eye, that betrays at once his uncivilizable tendencies.

Omitting these later importations, however—the modern plants, birds, and human beings—it may be fairly said that Australia is still in its Secondary stage, while the rest of the world has reached the Tertiary and Quaternary periods. Here, again, however, a deduction must be made, in order to attain the necessary accuracy. Even in Australia the world never stands still. Though the Australian animals are still at bottom the European and Asiatic animals of the Secondary age, they are those animals with a difference. They have undergone an evolution of their own. It has not been the evolution of the great continents; but it has been evolution all the same; slower, more local, narrower, more restricted, yet evolution in the truest sense. One might compare the difference to the difference between the civilization of Europe and the civilization of Mexico or Peru. The Mexicans, when Cortes blotted out their indigenous culture, were still, to be sure, in their stone age; but it was a very different stone age from that of the cave-dwellers or the mound-builders in Britain. Even so, though Australia is still zoölogically in the Secondary period, it is a Secondary period a good deal altered and adapted in detail to meet the wants of special situations.

The oldest types of animals in Australia are the ornithorhynchus and the echidna, the "beast with a bill" and the "porcupine ant-eater" of popular natural history. These curious creatures, genuine living fossils, occupy in some respects an intermediate place between the mammals on the one hand and the birds and lizards on the other. The echidna has no teeth, and a very bird-like skull and body; the ornithorhynchus has a bill like a duck's, webbed feet, and a great many quaint anatomical peculiarities which closely ally it to the birds and reptiles. Both, in fact, are early arrested stages in the development of mammals from the old common vertebrate ancestor; and they could only have struggled on to our own day in a continent free from the severe competition of the higher types which have since been evolved in Europe and Asia. Even in Australia itself the ornithorhynchus and echidna have had to put up perforce with the lower places in the hierarchy of Nature. The first is a burrowing and aquatic creature, specialized in a thousand minute ways for his amphibious life and queer subterranean habits; the second is a spiny, hedgehog-like nocturnal prowler, who buries himself in the earth during the day, and lives by night on insects which he licks up greedily with his long, ribbon-like tongue. Apart from the specializations brought about by their necessary adaptation to a particular niche in the economy of life, these two quaint and very ancient animals probably preserve for us in their general structure the features of an extremely

early descendant of the common ancestor from whom mammals, birds, and reptiles alike are originally derived.

The ordinary Australian pouched mammals belong to far less ancient types than ornithorhynchus and echidna, but they too are very old in structure, though they have undergone an extraordinary separate evolution to fit them for the most diverse positions in life. Almost every main form of higher mammal (except the biggest ones) has, as it were, its analogue or representative among the marsupial fauna of the Australasian region fitted to fill the same niche in nature. For instance, in the blue-gum forests of New South Wales, a small animal inhabits the trees, in form and aspect exactly like a flying-squirrel. Nobody who was not a structural and anatomical naturalist would ever for a moment dream of doubting its close affinity to the flying-squirrels of the American woodlands. It has just the same general outline, just the same bushy tail, just the same rough arrangement of colors, and just the same expanded parachute-like membrane stretching between the fore and hind limbs. Why should this be so? Clearly because both animals have independently adapted themselves to the same mode of life under the same general circumstances. Natural selection, acting upon unlike original types, but in like conditions, has produced in the end very similar results in both cases. Still, when we come to examine the more intimate underlying structure of the two animals, a profound fundamental difference at once exhibits itself. The one is distinctly a true squirrel, a rodent of the rodents, externally adapted to an arboreal existence; the other is equally a true phalanger, a marsupial of the marsupials, which has independently undergone on his own account very much the same adaptation, for very much the same reasons. Just so a dolphin looks externally very like a fish, in head and tail and form and movement; its flippers closely resemble fins; and nothing about it seems to differ very markedly from the outer aspect of a shark or a codfish. But in reality it has no gills and no swim-bladder; it lays no eggs; it does not own one truly fish-like organ. It breathes air, it possesses lungs, it has warm blood, it suckles its young; in heart and brain and nerves and organization it is a thorough-going mammal, with an acquired resemblance to the fishy form, due entirely to mere similarity in place of residence.

Running hastily through the chief marsupial developments, one may say that the wombats are pouched animals who take the place of rabbits or marmots in Europe, and resemble them both in burrowing habits and more or less in shape, which closely approaches the familiar and ungraceful guinea-pig outline. The vulpine phalanger does duty for a fox; the fat and sleepy little dormouse phalanger takes the place of a European dormouse. Both

are so ridiculously like the analogous animals of the larger continents that the colonists always call them, in perfect good faith, by the familiar names of the old-country creatures. The koala poses as a small bear; the cuscus answers to the raccoons of America. The pouched badgers explain themselves at once by their very name, like the Plyants, the Pinchwifes, the Brainsicks, and the Carelesses of the Restoration comedy. The "native rabbit" of Swan River is a rabbit-like bandicoot; the pouched ant-eater similarly takes the place of the true ant-eater of other continents. By way of carnivores, the Tasmanian devil is a fierce and savage marsupial analogue of the American wolverine; a smaller species of the same type usurps the name and place of the marten; and the dog-headed thylacinus is in form and figure precisely like a wolf or a jackal. The pouched weasels are very weasel-like; the kangaroo rats and kangaroo mice run the true rats and mice a close race in every particular. And it is worth notice, in this connection, that the one marsupial family which could compete with higher American life, the opossums, are, so to speak, the monkey development of the marsupial race. They have opposable thumbs, which make their feet almost into hands; they have prehensile tails, by which they hang from branches in true monkey fashion; they lead an arboreal omnivorous existence; they feed off fruits, birds' eggs, insects, and roots; and altogether they are just active, cunning, intelligent, tree-haunting marsupial spider-monkeys.

Australia has also one still more ancient denizen than any of these, a living fossil of the very oldest sort, a creature of wholly immemorial and primitive antiquity. The story of its discovery teems with the strangest romance of natural history. To those who could appreciate the facts of the case it was just as curious and just as interesting as though we were now to discover somewhere in an unknown island or an African oasis some surviving mammoth, some belated megatherium, or some gigantic and misshapen liassic saurian. Imagine the extinct animals of the Crystal Palace grounds suddenly appearing to our dazzled eyes in a tropical ramble, and you can faintly conceive the delight and astonishment of naturalists at large when the barramunda first "swam into their ken" in the rivers of Queensland. To be sure, in size and shape this "extinct fish," still living and grunting quietly in our midst, is comparatively insignificant beside the "dragons of the prime" immortalized in a famous stanza by Tennyson: but to the true enthusiast, size is nothing; and the barramunda is just as much a marvel and a monster as the Atlantosaurus himself would have been if he had suddenly walked upon the stage of time, dragging fifty feet of lizard-like tail in a train behind him. And this is the plain story of that marvelous discovery of a "missing link" in our own pedigree.

In the oldest Secondary rocks of Britain and elsewhere there occur in abundance the teeth of a genus of ganoid fishes known as the Ceratodi. (I apologize for ganoid, though it is not a swear-word.) These teeth reappear from time to time in several subsequent formations, but at last slowly die out altogether; and of course all naturalists naturally concluded that the creature to which they belonged had died out also, and was long since numbered with the dodo and the mastodon. The idea that a ceratodus could still be living, far less that it formed an important link in the development of all the higher animals, could never for a moment have occurred to anybody. As well expect to find a palæolithic man quietly chipping flints on a Pacific atoll, or to discover the ancestor of all horses on the isolated and crag-encircled summit of Roraima, as to unearth a real live ceratodus from a modern estuary. In 1870, however, Mr. Krefft took away the breath of scientific Europe by informing it that he had found the extinct ganoid swimming about as large as life, and six feet long, without the faintest consciousness of its own scientific importance, in a river of Queensland at the present day. The unsophisticated aborigines knew it as barramunda; the almost equally ignorant white settlers called it with irreverent and unfilial contempt the flat-head. On further examination, however, the despised barramunda proved to be a connecting link of primary rank between the oldest surviving group of fishes and the lowest air-breathing animals like the frogs and salamanders. Though a true fish, it leaves its native streams at night, and sets out on a foraging expedition after vegetable food in the neighboring woodlands. There it browses on myrtle leaves and grasses, and otherwise behaves itself in a manner wholly unbecoming its piscine antecedents and aquatic education. To fit it for this strange amphibious life, the barramunda has both lungs and gills; it can breathe either air or water at will, or, if it chooses, the two together. Though covered with scales, and most fish-like in outline, it presents points of anatomical resemblance both to salamanders and lizards; and, as a connecting bond between the North American mud-fish on the one hand and the wonderful lepidosiren on the other, it forms a true member of the long series by which the higher animals generally trace their descent from a remote race of marine ancestors. It is very interesting, therefore, to find that this living fossil link between fish and reptiles should have survived only in the fossil continent, Australia. Everywhere else it has long since been beaten out of the field by its own more developed amphibian descendants; in Australia alone it still drags on a lonely existence as the last relic of an otherwise long-forgotten and extinct family.—*Cornhill Magazine.*

SKETCH OF CARL FRIEDRICH GAUSS.

"IF we except the great name of Newton," says Prof. H. J. S. Smith, "it is probable that no mathematician of any age or country has ever surpassed Gauss in the combination of an abundant fertility in invention with an absolute rigorousness in demonstration which the ancient Greeks themselves might have envied." Wagener says, in the sketch of Gauss in the "Biographie Universelle," that each work of his is an event in the history of science, a revolution, which, overturning the old theories and methods, replaces them by new ones, and advances science to a height which no one had ever before dreamed of. The scientific estimate of Gauss's quality took another form in the expression of Laplace, who, when asked who was the greatest mathematician in Germany, replied "Pfaff." His interrogator remarking that he should have thought Gauss was, Laplace retorted, "Oh, yes, Pfaff is the greatest mathematician in Germany, but Gauss is the greatest mathematician in Europe."

CARL FRIEDRICH GAUSS was born in Brunswick, April 23, 1777, and died in Göttingen, February 23, 1855. His father was a brick-layer, and desired that the boy should be brought up to the same trade. But the lad had other tastes, and is said by some of his biographers to have displayed a greater precocity in his aptitude for mathematics than even Pascal. At three years old he could calculate and solve problems in numbers, and amuse himself by tracing geometrical lines and figures in the sand. He had, in fact, hardly reached that age when he ventured to tell his father concerning a certain account, "That is not right; it should be so much" —and was correct. At the age of ten he was acquainted with the binomial theorem and theory of the infinite series. Such gifts could not fail to attract marked attention from his teachers. The report of them reached Bartels, afterward Professor of Mathematics at Dorpat, and he brought the youth to the notice of Charles William, Duke of Brunswick, who undertook the charge of his education. Having, rather in opposition to his father's designs, learned all that the professors at the Collegium Carolinum could teach him, he went to Göttingen, in 1795, "as yet undecided whether to pursue philology or mathematics." The scale was probably turned by circumstances; one of them, perhaps, being the rare gifts of the mathematical professor, Kaestner, whom Gauss described as the "first of geometers among poets, and the first of poets among geometers"; and another, his success in solving the problem of the division of the circle into seventeen equal parts. Henceforth he made mathematics, which he styled "the queen of the sciences," the main study of his life, interesting himself par-

ticularly in arithmetic, "the queen of mathematics." After completing his course at the university, Gauss spent a short time in 1798 at Helmstadt, consulting the library there, and enjoying the society of his fellow-mathematician Pfaff. Having obtained a full supply of notes, he returned to Brunswick, and employed himself in the elaboration of the studies which have placed his name high in the list of eminent mathematicians.

In 1807 he was offered by the Czar of Russia a professorship in the Academy of St. Petersburg; but he declined the position, at the instance of Olbers, and because he felt that such a professorship would cramp his studies. His desire was to obtain the post of astronomer at an observatory, so that he could spend all his time on his observations and his studies for the advancement of science. This desire was gratified in the same year, when he was appointed Director of the Observatory and Professor of Astronomy at Göttingen. In this service he spent the rest of his life, never sleeping away from under the roof of the building, except in 1828, when he accepted an invitation to attend a meeting of the natural philosophers in Berlin, and in 1854—the year before his death—when, on the opening of the railway to Hamburg, he for the first time saw a locomotive. He consecrated all his time, says Larousse, "his genius, and his indefatigable activity, to the most abstract and profound researches in all branches of mathematics, astronomy, and physics. Endowed with most favorable health, possessing simple and modest tastes, so indifferent to display that he never wore any of the numerous decorations that the various governments decreed to him, Gauss had a gentle, upright, and correct character. Applying the greatest care to the preparation of his briefest as well as of his most elaborate memoirs, he would offer nothing to the public till it had received the last finishing touches from the workman's hand. He had engraved on his seal a tree loaded with fruit, encircled with the legend, '*Pauca, sed matura*' (few, but ripe). And he left a large number of works, which he did not consider mature enough to publish," but which arrangements were made after his death for having edited. "The genius of Gauss," Larousse continues, "was essentially original. If he was treating of a subject which had already engaged the attention of other students, it seemed as if their works were wholly unknown to him. He had his own manner of approaching the propositions, and his own method of treating them, and his solutions were absolutely new. These solutions had the merit of being general, complete, and applicable to all the cases that could be included under the question. Unfortunately, the very originality of the methods, a particular mode of notation, and the exaggerated, perhaps affected, laconicism of his demonstrations, make the reading of Gauss's works extremely

laborious. Hence, envious minds have not let the opportunity pass to reproach him with having made himself unintelligible in order to appear profound. The reason of this is, that Gauss does not leave visible any trace of the analytical course by which he has been led to the final solution. He used to say that when a monument is exhibited to the public there should remain no traces of the scaffoldings that have been used in constructing it. He was wrong in this; for, although it may be true that the scaffoldings ought to be withdrawn from the eye of the public, they should be for a certain time accessible to those of architects; and, even if they are out of use, they are sometimes the object of special descriptions, which make their merit understood. . . . Although Gauss is hard to understand as a writer, he was very clear as a professor. He was not, however, one of those mathematicians who are represented as being so deeply buried in their science as to have become strangers to the outer world. He used to talk pertinently and agreeably on subjects of philosophy, politics, and literature."

The charge of obscurity here brought against Gauss is reviewed by Prof. H. J. S. Smith, who says: "It may seem paradoxical, but it is probably nevertheless true, that it is precisely the effort after a logical perfection of form which has rendered the writings of Gauss open to the charge of obscurity and unnecessary difficulty. The fact is, that there is neither obscurity nor difficulty in his writings, so long as we read them in the submissive spirit in which an intelligent school-boy is made to read his Euclid. Every assertion that is made is fully proved, and the assertions succeed one another in a perfectly just analogical order; there is nothing, so far, of which we can complain. But, when we have finished the perusal, we soon begin to feel that our work is but begun, that we are still standing on the threshold of the temple, and that there is a secret which lies behind the veil, and is as yet concealed from us. . . . No vestige appears of the process by which the result itself was obtained, perhaps not even a trace of the considerations which suggested the successive steps of the demonstration."

According to M. Wagener, as summarized by Prof. Tucker, though Gauss looked upon mathematics as the principal means for developing human knowledge, he yet fully recognized the beneficial influence of an acquaintance with classical literature. He had, indeed, a wonderful faculty for the acquisition of languages; he was acquainted with most of the European languages, and could speak many of them well. At the age of sixty-two he took up the study of the Russian language, and he mastered it in two years. He took a great interest in politics till within a few weeks of his death. "His lectures, in which he adopted the ana-

lytic method, were exceedingly clear expositions; in them he liked to discuss the methods and the roads by which he had arrived at his great results. He required the closest attention, and objected to the taking of notes, lest his hearers should lose the thread of his argument. The students seated round the lecture-table listened with delight to the lucid and animated addresses of their master; addresses more resembling conversations than set lectures."

Gauss's writings are upon subjects of arithmetic, algebra, and astronomy. The fullest list, that given in the Royal Society's catalogue of scientific papers, contains one hundred and twenty-four titles, but does not include his largest works. The most important papers are on arithmetic, while only a very few of the number are algebraic, and they all relating to a single theorem. Prof. Cayley remarks that of the memoirs in pure mathematics "it may be safely said that there is not one which has not signally contributed to the progress of the branch of mathematics to which it belongs, or which would not require to be carefully analyzed in a history of the subject." One of his earliest discoveries was "the method of least squares," which, though first published by Legendre, he applied as early as 1795. His first published paper—a thesis for the Doctorate of Philosophy, in 1799—was devoted to the demonstration that every equation has a root; and of this theorem he made two other distinct demonstrations in 1815 and 1816. But these works, though he was the first in the field on the subject, gave him no fame. Lagrange seems not to have heard of the first one; and Cauchy, whose subsequent demonstrations have been preferred, received in France all the praise due to a first discoverer. The "Disquisitiones Arithmeticæ," which is perhaps his principal work, contains many important researches, one of which, known as the celebrated Fundamental Theorem of Gauss, or the law of Quadratic Reciprocity of Legendre, of itself alone, Prof. Tucker says, "would have placed Gauss in the first rank of mathematicians." The author discovered it by induction before he was eighteen years old, and worked out the first proof which he published of it in the following year. He was not satisfied with this, but published other demonstrations resting on different principles, till the number reached six. He had, however, been anticipated in enunciating the theorem, but in a more complex form, by Euler, and Legendre had unsuccessfully attempted to prove it. "The question of priority of enunciation or of demonstrating by induction," says Prof. Tucker, "in this case is a trifling one; any rigorous demonstration of it involved apparently insuperable difficulties." Another discussion involves the theory of describing within a circle the polygon of seventeen sides; another, the theory of the congruence of numbers, or the relation that exists between

all numbers that give the same remainder when they are divided by the same number. In his "General Disquisitions on Curved Surfaces," he established the famous theorem that in whatever way a flexible and inextensible surface may be deformed, the sum of the principal curvatures at each point will always be the same. The calculations of the elements of the asteroids Pallas, Ceres, Juno, and Vesta, were made by Gauss, and attracted all the more attention because they furnished the first occasions on which all the elements of a planet had to be determined in a short time and by a small number of observations. The methods were not yet even fixed, because no one had taken up the subject. The process adopted by Gauss was simple and confessedly worthy of the attention of astronomers. Gauss has been called the godfather of the planet Vesta, from his having selected the name for it. In two papers on the comets of 1811, he gave a new and much more simple method than had been practiced before to determine the elements of a comet with the smallest number of observations. While actively engaged in the measurement of the degree in Hanover, Gauss devised the instrument known as the heliotrope, which has since come into general use in all geodesic observations.

Gauss engaged also in researches on magnetism, concerning which he published a paper in 1833 on the intensity of terrestrial magnetism. He and Prof. Wilhelm Weber invented new magnetic apparatus, including the declination instrument and the bifilar magnetometer. They erected at Göttingen an observatory, free from iron, where he made magnetic observations, and—anticipating the electro-magnetic telegraph—sent telegraphic signals to a neighboring town.

His collected works, edited by E. J. Schering, have been recently published by the Royal Society of Göttingen in seven volumes. With them are included notices by him of many of the memoirs, and of works of other authors in the "Göttingen gelehrte Anzeigen," and a considerable amount of previously unpublished matter. Gauss was a member of all the important learned societies.

One of Gauss's last acts was, a little while before his death, to have engraved at the foot of his portrait, as giving the best summary of his views and labors, the lines from Shakespeare's "King Lear":

> "Thou, Nature, art my goddess; to thy laws
> My services are bound."

CORRESPONDENCE.

EDUCATION FOR MOTHERS.

Editor Popular Science Monthly:

MR. GEORGE L. GUY, in his address quoted from in one of the "Notes" of the April "Popular Science Monthly," asserts that "our bookish education" does not "in any sense fit our young people to enter upon the practical duties of life."

Why should it not? If a physician be called to attend a very ill child when perhaps the nursing is most important, which will give him the greatest sense of strength—the ignorant mother blindly striving to ease present pain regardless of future consequences, or the woman accustomed to use her reason? The first perhaps can not even read the labels on his bottles, the second can take notes of all he directs and give him on his return a faithful account of what has passed during his absence.

Often a mother's daily wish is that her education had been better, that she might more easily keep pace with her sons, who demand her sympathy in their intellectual pursuits, knowing that she can not share in their rough play. There are many rainy days, times of sickness or *ennui*, when the boys want occupation that can satisfy their growing minds, and yet not savor too strongly of the school-room. If their mother can make history interesting from her own full knowledge, which enables her to select a good book or to embellish a rather dull one, even quite little fellows will turn from childish stories with delight to listen. Another child longs to know something of the great forces about him. Why does an engine go? What is a compass? Endless are the questions, and happy the mother who can keep her sons about her while together they find the answers. If she can draw, again there is a pleasure in the lessons she can give in odd moments, and, almost without a thought on the child's part, he finds he can use a pencil, enjoying it in untold ways. It is the same with music, with the languages, botany, and many other studies. Children can not learn all they need at school, neither can we give them too many extra hours for lessons. Their afternoons and holidays must be as free for pure play as possible; but when, owing to circumstances, that can not be had, do not let them be idle; help them to the habit of employing their minds or hands usefully. How can a mother do that, especially for boys, if she only knows how to sew, to keep a house in order, and attend to the younger children? The baby needs her care for its frail bodily life—do not the minds and souls of her older children also cry out to her? MRS. WILLIAM F. JENKS.

PHILADELPHIA, PA., *March* 27, 1888.

THE UNITY OF TRUTH.*

Editor Popular Science Monthly:

WE still hear from time to time of sad examples of dogmatic utterances of the Church on subjects pertaining wholly to science. The last of these occurred only a few weeks ago at Baltimore. It seems impossible for most people to learn from experience unless the experience be personal. Only the reflective learn wisdom from history.

It is for this reason that we hail with pleasure the work before us. Its liberal spirit is as rare as its Christian fervor is deep. When clergymen have the boldness to write such books, and congregations the liberality of thought to receive such instruction, surely the traditional conflict between theology and science is nearing its end.

The writer assumes throughout the truth of evolution, and strives with great learning and eloquence to show that it does not destroy but only confirms all that is most essential in Christian belief.

We most heartily recommend the book to all truth-seekers, and especially to clergymen of all denominations.

JOSEPH LE CONTE.

BERKELEY, CAL., *June* 12, 1888.

MORE ILLS OF CITY LIFE.

Editor Popular Science Monthly:

THE article by Walter B. Platt, M. D., on "The Injurious Influences of City Life," in the August "Monthly," suggests a mention of the mental and nervous irritation caused by the petty annoyances and trespasses on individual rights constantly being inflicted by the jostling throng of a city. We are elbowed and nearly upset, our toes are trodden upon, and our sides are punched with umbrellas and market-baskets by the crowd in cars and ferry-boats, which are crowded because the corporations that own them take our money without giving us proper accommodations in return. At places of amusement, our view is cut off by persons who stand up or sit with large hats on in front of us. At home, dwellers in flats receive various disagreeable sounds and smells from their too close neighbors. In hardly any place are we secure from being pestered

* "The Unity of Truth." By Rev. Max Hark.

to buy what we do not want, or being tortured with wretched music and then asked to pay for the infliction. These things and many others of like nature produce more or less mental irritation, according to the sensitiveness of the individual, and help to make up the too great load which the nerves of city dwellers have to bear.

Still another injurious influence, more similar to those mentioned by Dr. Platt, comes from the frequent startling by sudden noises, or the sudden appearance of danger in city streets. As Dr. Platt pointed out, the noises of a city are legion. Many of these are so loud and abrupt as to cause a momentary fright; for instance, the crash of wagons and cars in collision, the striking and scraping of the hoofs of horses struggling for a footing on a slippery pavement, the fall of cases, barrels, iron rails, etc., being unloaded from trucks, the blasting for the foundations of buildings (in the outskirts of the city), and other noises, which, while no one may occur often, together make up a large aggregate. In addition to these startling sounds, the city dweller is continually receiving impressions of impending danger through the eye. Among these are the causes of the noises just mentioned, if they are close at hand—the toppling wagons, the plunging horses, and the boxes of goods and pieces of building-material escaping from the hands of workmen. Also may be mentioned recklessly driven vehicles, coming upon a foot-passenger from behind at street-crossings; the sudden appearance close to one's face of a long pole, gas-pipe, or other burden carried on the shoulder of a man along a crowded sidewalk; and many similar things incidental to the compressed activity of a city. The shock to the nerve-centers which these momentary frights give, and the nervous strain which the city dweller endures from keeping a lookout for such dangers, can not fail to impair the strength of the nervous system. Through the nerves an injurious influence is exerted upon the heart also. Sudden fright, or other violent emotion, disturbs the working of the heart, and often so far arrests its action as to produce fainting, while cases of immediate death from this cause have been known. Even when the fright is not serious, the cumulative effect of being startled so often must contribute to the growing frequency with which the city dweller "breaks down but doesn't wear out."

FREDERIK A. FERNALD.

NEW YORK, *July* 18, 1888.

THEORIES OF THE CAUSES OF BALDNESS.

Editor Popular Science Monthly:

FROM time to time I have noticed theories expressed in the "Monthly," setting forth the chief causes of baldness, such as abnormal heat from the head-cover, "constriction of the blood-vessels of the head by tight hats," by Mr. Eaton and Mr. Gouinlock. Prof. T. Wesley Mills holds that "the principal root of the trouble is in nervous strain." All these theories may have something to do with the loss of hair. I am not about to discuss these several theories, or suggest one myself, but will only endeavor to point out a few facts which may be interesting as bearing upon the subject. During several years' residence in Hong-Kong, in my professional duties I had to do with a goodly number of persons, representing a large variety of nationalities, and in my study of these people I found that many theories deduced from local experiences at home were, in some cases at least, hardly broad enough to cover all facts found at large in nature bearing upon the specific points of investigation. Familiar with some of the popular theories as to the cause of baldness, I was surprised to find men who always wore a covering to their heads, and during business hours and always when out of doors wore a very tight hat, were never bald, and possessed a wonderfully strong, thick head of hair. I refer to the Parsees (Persians). There is a sacred, religious law among them that no man shall go with his head uncovered. When the Mohammedans invaded Persia, the major part of the native Persians that were not exterminated fled farther east into India, found protection and a welcome home among the Hindoos, a people of *castes*, and, in order that these strangers should always be identified, also knowing that their religion obliged them to wear a head-cover, a law was passed to compel all Parsees (Persians)* to wear a certain style of hat whenever exposed outside of their own private home. The hat prescribed is as tall as an American silk hat with no brim; it truly might be called a "stove-pipe." This hat is worn, inclining backward on the head from thirty-five to forty degrees, and, in order to keep it on its place, the rim is made to cling very close to the head; being so tight and so constantly worn, quite a deep depression is caused substantially around the head; it seemed as if the skull might be involved, but, not having the opportunity of examining one, I was not able to fully determine. Whenever this hat is removed, a skull-cap immediately takes its place. In my professional duties, these hats often had to be removed, and it appeared to me as a curious fact—if some of the popular theories were altogether true—that these people should never be bald. Therefore, I instituted a series of strict inquiries. Many of these gentlemen spoke English intelligently, also French, German, Persian, and their local Hindoo dialect, some of whom kindly allowed an examination of their heads, and also assured me that they had never known one of their race that was bald.

G. O. ROGERS.

CITY OF MEXICO, *April* 19, 1888.

* The term Parsee (Persian) is used in contradistinction to the invading Mohammedan Persians, who are now habitants of the country.

EDITOR'S TABLE.

THE OPPOSITION TO DARWINISM.

THE "Contemporary Review" for June contains a timely article by Mr. Romanes in reply to recent attacks on Darwin and the Darwinian theory of natural selection. Mr. Romanes first applies himself to answering an anonymous writer in the "Edinburgh Review," who, not content with opposing Darwinism, assails the character of Darwin himself. Here Mr. Romanes has an easy task; for, if anything is obvious to an ordinarily candid mind, it is that the author of the theory of natural selection was a man of a rare elevation and disinterestedness of spirit—a man whom, so far as his personal attributes were concerned, any school of thought might be proud to call its chief. The "Edinburgh Reviewer" tries to prove from the "Life and Letters" that Darwin was a vain man, wedded to his own notions, greedy of flattery, and impatient of criticism. The record is there; he who runs may read, and no one save the reviewer has yet read what he professes to have done.

Mr. Romanes's more serious concern, however, is with the criticisms of the Duke of Argyll; and, to our mind, he deals in a very effectual manner with that writer's contention that natural selection can in no sense be a cause of the formation of species. Natural selection, it is urged, does not produce the variations that occur in Nature—*ergo*, it can not explain the origin of species. To this Mr. Romanes replies that natural selection is precisely the thing which gives vitality and perpetuity to certain variations, and which causes others to perish, and that, in that sense, it is as truly a cause of species as any one thing can be of another. If natural selection is not a cause of species, then neither is the intervention of the breeder a cause of the varieties which we know his art produces among domestic animals; for the breeder does not make the congenital variations upon which he works; he simply chooses among them those which he wishes to preserve and, if possible, establish and develop. If the reaction of the environment exercises a selective influence upon variations spontaneously produced, extinguishing most, favoring a few, we may with perfect propriety speak of that as "natural selection," and may regard it as a cause of species just as we regard any other necessary antecedent or condition of a given phenomenon as a cause of that phenomenon. We need not personify it in doing so, need not make a metaphysical entity of it; all we are called on to do is to attest the fact—if the facts appear to warrant it—that, by a process of natural selection, species are formed.

But Mr. Romanes makes a very true remark when he says that the Duke of Argyll's quarrel is really not with natural selection as a special theory, but with natural selection considered as one aspect of the general doctrine of evolution. What his Grace objects to is that idea of *natural causation* which the doctrine of evolution implies; for there would be absolutely no advantage, from the duke's point of view, in destroying the theory of natural selection if the scientific world were straightway to set about discovering some other natural hypothesis to take its place. What the duke, therefore, has to show is that nothing can be naturally explained, and therefore that all attempts of the nature of Darwin's are predoomed to failure. The moment we admit the efficacy of natural causes at all we start upon a career of explanation to which, in the very nature of things, there are no lim-

its. If, therefore, the Duke of Argyll does not wish us to frame large hypotheses, he must prohibit and prevent our forming small ones. He must break us into seeing miracle everywhere. There is really no tenable middle ground between the reign of superstition, with all its blindness and terrors, and the reign of science, with its calm, undismayed survey of realities. The Duke of Argyll and other assailants of evolution may find many flatterers among the timid and the reactionary, but they will not persuade the world to return to the standpoint of the middle ages, nor will they ever succeed in appreciably retarding the march of science or the growth of a scientific philosophy.

PETITIONS FOR RAIN.

The vicissitudes of the seasons give rise every year to more or less controversy as to the propriety and efficacy of petitions for changes in the weather; and we notice discussions of this character now in progress in different quarters. It is ill arguing against sentiments that have almost the force of instincts; and we have no wish to say or do anything calculated to check the exercise of a religious spirit. The number, however, is probably increasing from year to year of those who are disposed to regard the question referred to mainly as one of evidence, and in the few remarks we have now to make, it is this class exclusively that we have in view.

Among the things we know on this subject is the fact that, in all ages, the weather has been a frequent cause of anxiety to mankind, particularly to those immediately depending on the soil for the reward of their labor. In all ages there have been seasons of hurtful drought and seasons of excessive rain, seasons of deficient heat and seasons of undue heat, and men have been compelled to adapt themselves to these varying conditions as best they could. Occasionally the abnormities of the weather have been such as to produce famine on a wide scale; and it is to be remarked that the intensity of these visitations has been proportioned to the ignorance and general backwardness of the communities upon which they have fallen. In all ages prayer has been resorted to as a means of obtaining propitious seasons, and often it has been re-enforced by sacrifices, human or other; but history furnishes no evidence whatever that the weather has at any period, or under any religious dispensation, been governed or modified by such expedients. What has been the case in the past holds good to-day. We have, like the ancient Romans, Greeks, Indians, and Chinese, our favorable seasons and our unfavorable ones. The farmer has his battles to fight just as of old; and there is, perhaps, reason to believe that his more highly developed, or, at least, specialized strains of fruits, vegetables, and grains are more liable to the attacks of parasites, and more sensitive to atmospheric conditions, than were those of ancient times. On the other hand, the civilized farmer of our century has a greater command of scientific knowledge wherewith to combat his foes than was possessed by the agriculturist of two thousand or even of one hundred years ago, while the community as a whole possesses resources of capital and facilities both of communication and of transportation such as to put famine on a large scale almost out of the question. We may thus claim to have positive and conclusive evidence that the security of human life depends in the most direct manner on knowledge and social organization, while we are compelled to recognize a complete lack of evidence that it depends directly or indirectly on anything else. What is true of the vicissitudes of the seasons is true also of diseases and pestilences. Prayer has always been resorted to to ward them off; but history tells us that, in ages of ignorance, they were vastly more severe and destructive than they

are to-day. We combat them successfully by knowledge: that is evident; and it is not evident, nor, indeed, is there a scintilla of proof, that we combat them successfully by anything else. Of course, if we choose, we may believe without evidence; but whether it is wise to force belief in this manner, or to allow it to be dominated by mere sentiment, each one must decide for himself.

To us it seems the part not of wisdom only, but in a true sense—the truest sense—of piety also, to take the world as we find it; to acknowledge, with Matthew Arnold, that

> "Limits we did not set
> Condition all we do";

and then to apply ourselves with all the courage and energy we can command to making the best of the conditions we find prevailing. The more adverse those conditions, the more scope there is for the active brain and resolute will. The intellectual advancement of the civilized man of our day is a measure of the difficulties he has faced and overcome. The most wholesome view, therefore, to take of an unfavorable season is to regard it as an obstacle thrown by the constitution of nature in the way of human effort, but an obstacle which, by developing patience and stimulating reflection, may itself be productive of good results. It is doubtless hard to be philosophical when severe pecuniary loss is staring one in the face; but it may not be amiss to reflect that what to-day is a matter of not irremediable loss might, in days when faith was more active but knowledge more scanty and co-operation less developed, have meant actual death by starvation. It is something to live in an age and belong to a community in which industrious men do not starve, even in the worst of times. If, therefore, we can not command the weather, let us make the best of such weather as we can get, and strive by forethought, by energy, by co-operation with our fellows, to establish more and more effectual compensations for the inequality of the seasons and whatever other disadvantages may be inseparable from our existence on a globe which probably was not fashioned solely with a view to our comfort.

THE PURPOSE OF MANUAL TRAINING.

Our "Popular Miscellany" last month contained two paragraphs in which were embodied some excellent thoughts on the value and purpose of technical education, or "hand-training," in schools. The analysis of the real object of the instruction given by Prof. Le Conte so clearly indicates the direction which the teaching should take, and the tendencies it should encourage, that it may well be referred to again.

As drawing should be taught, Prof. Le Conte affirms, not for making artists, but for training the brain through eye and hand, so hand-work instruction should be given with a similar aim, rather than for making carpenters and blacksmiths. While in biology the training is mainly of the brain through the senses, in hand-work it is mainly of the brain through the hand. If the former is mainly observing and thinking, the other is mainly thinking and doing. It is impossible to doubt the importance of hand-training from this point of view. The absolute necessity of the use of the hand in the brain-culture of the child, and the importance of the use of instruments of research in the best scientific culture of the university, are now admitted by all. But in the wide space between these extremes of the educational course—viz., in the school and the college—this great agent of culture is wholly left out. Now, it may be assumed as certain that for every grade of culture, whether of the individual or of the race, there is a corresponding grade of hand-work necessary for the best brain-development. In the child of pre-school age, and in the savage, it is the simple use of the hand, or of the hand assisted by rude implements. In

the school boy or girl, as also in the next grade of civilization above the savage, the object is furthered by the use of those finer instruments which we call tools. In the university, as in the most civilized races, it is by the use of scientific instruments and machines. The three grades of hand-work, then, in their adaptation to brain-culture, are the use of rude implements, tools, and finer instruments.

Mr. G. S. Ramsay has shown that the advantages which workmen of certain other countries are supposed to possess over British workmen in the same trades are due not so much to mere special skill in manipulation as to the superior general scientific knowledge possessed by them and those who have the directing of them. The German beet-sugar industry has attained its great proportions by making the technical part of the work subordinate to the scientific principles on which it is based. So American and Canadian butter and cheese have gained the predominant place in British markets through the makers having been wide-awake and having adopted all the scientific improvements in treatment and processes which the home makers neglected. In each of these and other cases cited by Mr. Ramsay we find the same state of things: the producer "fails to understand the importance of pure knowledge; he despises and disbelieves in principles, and imagines that the only thing he need know is what applies to his own particular work."

These views are wholesome, and it promises well for the future of technical education that they are gaining currency among the persons who are endeavoring to make this branch of instruction a living fact in schools.

Lord Armstrong, criticising, in the "Nineteenth Century," the English system of elementary education, charges it with being liable to the radical objection of "aiming at instruction in knowledge rather than in the training of the faculties," and adds that "cheapness of production and superiority of quality will decide the victory in the race of competition, and if by early training we develop the mental and bodily faculties of our people, we shall improve our chance of maintaining a foremost place; but not, I think, by any forced or indiscriminate system of imparting knowledge." This declaration was partly accepted and enlarged upon by Lord Hartington, in an address in behalf of the English National Association for the Promotion of Technical Training.

The same thought has been expressed by Lord Ripon, who gave as a reason for being specially interested in the school of handicraft, of which he is patron, that he hoped it might become a center of artistic education for the workingmen, and that they might derive from it not merely benefit in regard to their particular trades, but also in regard to their intellectual advancement and cultivation. By exciting the interest of workmen in their work, and by finding play for their imagination and other faculties, the institution might do something to solve some of the most difficult of existing social problems.

Such declarations, coming from different quarters and made from so many points of view, tend to strengthen the hope that technical education will be built up on the right grounds, firm and solid ones, and that when it has gained its place it will have come to stay. Removed from the narrow basis of merely imparting special knowledge in particular processes to the broader and comprehensive one of fitting those who apply themselves to it both mentally and bodily for pursuits requiring skill and intelligence, it will be brought into harmony with the controlling principle that education is good in proportion as it tends to develop capacities for useful action rather than to increase acquirements in knowledge, and will be destined to form an inseparable part of such education.

LITERARY NOTICES.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION, TO JULY, 1885. Part II. Washington. Pp. 264 + 939.

THE first portion of this volume comprises the report of the United States National Museum, made by the assistant director, Prof. G. Brown Goode, reports of the curators of the several departments, a bibliography of the museum publications, and a list of accessions to the collections. These documents cover only the first half of the year 1885, because the reports of the Institution in future are to cover the fiscal instead of the calendar year. The more considerable part of the volume embodies a monograph, by Thomas Donaldson, on "The George Catlin Indian Gallery in the United States National Museum, with Memoir and Statistics," which is illustrated with one hundred and forty-two plates and several maps and portraits. From Mr. Donaldson's memoir, it appears that George Catlin was born at Wilkesbarre, Pa., July 26, 1796, and died at Jersey City, N. J., December 23, 1872. He studied law at Litchfield, Conn., and while there became noted as an amateur artist. He began practice in Luzerne County, Pa., but the law soon had to give way to art, and he removed to Philadelphia in 1823, where he became very popular as a miniature and portrait painter. Catlin's boyhood was passed on his father's farm in the Ocquago Valley, Broome County, N. Y., and on another near Hop Bottom, Pa. The Indians were then being pushed further west, but the locality was still rife with tales of the red men and the pioneers. George's father had served six years in the Revolutionary War; his grandfather on his mother's side had escaped from the "Wyoming massacre" by swimming the river; and when the Indians captured Forty Fort his grandmother and his mother, then a girl of seven years, were among the prisoners. Thus the recollections of his own family, and the stories told by the Revolutionary soldiers, Indian fighters, hunters, trappers, and explorers, who were frequent guests at his father's house, aroused in young George's mind that interest in the Indians which was to become his ruling passion. "The plows in my father's fields," Catlin afterward wrote, "were daily turning up Indian skulls or Indian bones, and Indian flint arrow-heads, which the laboring-men of his farm, as well as those of the neighborhood, were bringing to me, and with which I was enthusiastically forming a little cabinet or museum. . . . I was in a position to increase rather than to diminish the excitement already raised in my mind relative to the Indians." While practicing his art at Philadelphia, he says, "my mind was continually reaching for some branch or enterprise of the art on which to devote a whole lifetime of enthusiasm, when a delegation of some ten or fifteen noble and dignified-looking Indians from the wilds of the far West suddenly arrived in the city, arrayed and equipped in all of their classic beauty. . . . In the midst of success (as a painter) I again resolved to use my art and so much of the labors of my future life as might be required in rescuing from oblivion the looks and customs of the vanishing races of native man in America." This resolve was carried out in his "Indian Gallery," to which he untiringly devoted himself during forty-two years. From 1829 to 1838 Mr. Catlin lived among the Indians, traders, trappers, and hunters of the West, and in this period created the original "Catlin Gallery." His adventures, as recounted in his "Eight Years among the North American Indians," are most entertaining. The medicine-men in some places aroused an opposition to his painting by asserting that the operation took away part of the life of the sitter. But the good-will of a powerful chief generally turned the tide in his favor, and the portrait-making became an honor. But this introduced a new embarrassment when he proposed to paint some of the women, they not being deemed worthy of such distinction. After much debate this also was permitted. Catlin's "Indian Gallery" was exhibited in this country, England, and France, from 1837 to 1852. During this period Mr. Catlin won the esteem and friendship of explorers, scientists, statesmen, and artists, among whom were Mayne Reid, Joseph Henry, Henry Clay, Benjamin Silliman, von Humboldt, Bunsen, William M. Hunt, Daniel Webster, William H. Seward, John A. Dix, Michael Faraday, and John Murray. Before going to Europe he had attached to his gallery of six hundred paintings a museum of several thousand Indian articles,

and during his stay abroad three parties of Indians, brought over by other persons, were exhibited under his management. His "Notes in Europe," describing his experiences, is singularly interesting, especially the parts telling the impressions of European customs gathered by his Indians. In 1852 Mr. Catlin was overtaken by financial disaster, and his gallery and museum were seized, but were released by Mr. Joseph Harrison, Jr., who shipped them to Philadelphia, where they were stored till 1879. From 1846 to 1874 several unsuccessful attempts were made to persuade Congress to buy the Catlin collection. Finally, in 1879, Mr. Thomas Donaldson solicited of the executors of Mr. Harrison the gift of the collection to the Smithsonian Institution, which was speedily effected. In 1852 Mr. Catlin went to South America, visiting the Indians of the Orinoco and Amazon regions, and crossing the Andes to Lima, whence he sailed northward to Panama, California, British Columbia, the Aleutian Islands, and Kamchatka. Returning southward, he visited Yucatan, and, after a trip to France, continued his explorations in Uruguay, Paraguay, and the country south to the Strait of Magellan, and also made some geological observations in Venezuela. These travels are described in his books, "Life among the Indians," "Last Rambles," and "Lifted and Subsided Rocks of America." He went to Europe in 1853, where he remained, painting his "Cartoon Collection," till 1870, when he returned to the United States, and exhibited the collection till his death. The "Catlin Cartoon Collection" consists of copies of some of the original gallery, with a large number of North and South American Indian portraits and scenes, in all six hundred and three pictures. It is now the property of Mr. Catlin's three daughters. A large part of Mr. Donaldson's monograph consists of a catalogue of the Catlin Gallery, interspersed with biographical material from Catlin's books and other sources, concerning the famous Indians whose portraits are therein preserved, and with copious notes on the landscapes, sporting-scenes, manners and customs depicted in the views. The plates which illustrate the paper are reproductions of the paintings. The catalogue is followed by the "Itinerary of Mr. George Catlin, 1830 to 1871, with Notes." The concluding portion of the volume is a sketch of the Indian policy of the Government from 1776 to 1886, with statistics, and includes a map showing all the Indian reservations in the United States in 1885, and another, on a large scale, of the Indian Territory. It is rare that so readable a volume comes from the Government Printing-Office.

PRINCIPLES OF THE ECONOMIC PHILOSOPHY OF SOCIETY, GOVERNMENT, AND INDUSTRY. By VAN BUREN DENSLOW, LL. D. New York: Cassell & Co. Pp. 782. Price, $3.50.

THE dignity of a science is readily claimed for political economy by these who talk or write about it. Yet the application of scientific principles to the investigation of the subjects embraced under that head, or a suggestion to enforce practically the results of a purely scientific investigation, is scornfully rejected by the whole of one of the great schools of economists. Hence, the author, who writes from the point of view of this school, is capable of saying that "political economy has thus far been conducted in a way that makes it a body of fault-finding and carping, by men innocent of any connection with government and but slightly acquainted with business, as to the effect of that legislation whose responsibilities they have never borne, upon that industry toward which they maintain a parasitic rather than a controlling relation." Among the men thus ungraciously snubbed are such authorities as Adam Smith, Mill, Bastiat, Jevons, Cairnes, Bonamy Price, Fawcett, Thorold Rogers, Sumner, John Bright, Prof. Perry, and others, to whose lucid and convincing expositions of the solid elements of national prosperity the world at large has been glad to give an attentive ear. So, "apprehending that political economy must needs teach the functions of government concerning industry, it next follows that the economist must no longer be a member of a mere sect of anti-government critics. Political economy can not attain its true dignity as a scientific expositor of the relations of government to industry so long as the statesmen of the world monopolize the ability to see things as they are, and to do things in a way that is practicable, while the economists indulge in the mere imaginative occupation of theorizing in the

subjunctive mood as to how they might, could, would, or should do. It is time that the economists of every country had ceased to be a sect antagonizing the statesmen; especially is it time that the economists of America, France, and Germany had ceased, in antagonizing the statesmen of their own country, to fall into a species of disloyal alliance with the statesmen of countries whose economic interests may not be in harmony, in certain important and vital aspects, with their own"—the familiar cry of the practical politicians against the "literary fellers." In spite of this one-sidedness, there is a great deal that is valuable in the book, in the fullness of the historical presentations of the various questions, the ample citations of facts, the author's own lucid comments where his bias does not overrule him, and the notes giving views of nearly all economists, all going to justify his belief that it may prove "convenient as a book of reference to the very large number of persons who, if amply supplied with facts, find it not difficult to arrive at their own conclusions." One feature that we can commend in the highest degree is the excellence and fullness of the table of contents and the two indexes. Among the subjects specifically treated are "Wealth," "Value and Prices," "Title and Use," "Profit and Loss," "Capital," "Land," "Labor," "Money," "Crises," "The State" as a factor in various ways, and the different aspects of taxation, protection, and free trade.

PHYSICAL DEVELOPMENT; OR, THE LAWS GOVERNING THE HUMAN SYSTEM. By NATHAN ALLEN, M. D. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 348.

DR. ALLEN has been known for twenty-five years as a writer on the various subjects that fall under the heading of the title of this book. While some of the papers have appeared in special journals and the transactions of societies, many of them have been published in channels through which they went at once to general readers. In all his work he has sought to improve the standard of American manhood and womanhood. Two of the papers in this volume—"Changes in New England Population" and "The Law of Human Increase"—appeared first in "The Popular Science Monthly"; and the former paper, with the one on "The New England Family," attracted very general attention, and were extensively copied and commented upon. They exposed a sore spot in the domestic economy of Americans, and pointed out an evil concerning which there was more sorrowing in silence than brave remarking. There is no doubt that their influence was wholesome, and that in publishing them Dr. Allen did a service to his country. The other papers—there are twenty-four in all—if of less pronounced importance, are valuable as teaching truths bearing upon the health and longevity of the race, and presenting them in such a literary form as to commend them to general reading. We observe that they have been edited in such a manner as to constitute the volume, instead of a mere collection of scattered essays, a compact and harmonious book. The papers are preceded by a biographical sketch of the author, which is accompanied with an excellent steel-engraved portrait.

SYSTEM OF ECONOMICAL CONTRADICTIONS; OR, THE PHILOSOPHY OF MISERY. By P. J. PROUDHON. Vol. I. Boston: Benjamin R. Tucker. Pp. 469. Price, $3.50.

MR. TUCKER is engaged in publishing, by subscription, the complete works of the French socialistic philosopher, in fifty volumes, of which this is in order the fourth, although the second and third volumes have not yet been published in English. As implied in the title, the book is in reality a budget of contradictions, beginning with the question of the existence of God, in respect to which positive and negative statements are hypothecated. Social economy is distinguished by an opposition between fact and right; the science is real, but it is "an immense plain, strewn with materials prepared for an edifice. The laborers await the signal, full of ardor and burning to commence the work; but the architect has disappeared without leaving the plan." The principle of value is discussed in the light of the opposition of value in use and value in exchange. Division of labor is studied as the economic fact which influences most perceptibly profits and wages. The machine and the workshop having given the laborer a master and reduced him from the rank of artisan to that of common workman, the problem is in place

how to cause them, instead of serving exclusively the interests of the least numerous, the least industrious, and the wealthiest class, to be employed for the benefit of all. Against these evils, Providence has sent us competition, whose opposite is monopoly, another evil; and socialism, while it has not succeeded in regulating competition and keeping it from becoming anarchical, is powerless against monopoly, so that we see all reforms ending "now in hierarchical corporation, now in state monopoly, or the tyranny of communism." These contradictions and evils constitute a "long succession of torments" through which it was necessary that society should pass in order that the victory of intelligent and free labor might produce all its consequences. Still other necessities must be met, to disappear, until "the supreme necessity, the triumphal fact, which must establish the kingdom of labor forever," shall come at last.

THE AMERICAN ANTHROPOLOGIST. Quarterly. Washington: Thomas Hampson. Price, $3 a year.

WITH January, 1888, the Anthropological Society of Washington began the publication of this magazine as a continuation of the "Transactions" heretofore published, and for the additional purpose of affording a medium for recording the work of investigators in anthropology who are not members of the society. The first number contains four papers: "The Law of Malthus," by Dr. James C. Welling; "The Development of Time-keeping in Greece and Rome," by F. A. Seely; "Anthropological Notes on the Human Hand," by Frank Baker, M. D.; and "The Chane-abal Tribe and Dialect of Chiapas," by Daniel G. Brinton, M. D. Dr. Baker's paper is of a popular character, dealing with beliefs in the curative or magical virtue of the "dead hand," with palmistry, with expression in the hand, etc. The second number contains the annual address of the retiring president of the society, Major J. W. Powell, delivered March 16, 1886. This is followed by a review of Dr. Rink's "Eskimo Tribes," a paper on "Discontinuities in Nature's Methods," by Henry H. Bates, and "The Prayer of a Navajo Shaman," by Dr. Washington Matthews, with miscellaneous notes and news.

A Hand-Book of the Lick Observatory has been written by the director, Prof. *Edward S. Holden* (The Bancroft Company). The book contains a sketch of the life of James Lick, descriptions of Mount Hamilton, and the buildings and instruments of the Lick Observatory, information for intending visitors, a poem "To the Unmounted Lens," by A. V. G., together with chapters on the work of an observatory, telescopes, astronomical photography, clocks and time-keeping, and the principal observatories of the world. The text is illustrated with woodcuts.

A little book of *Chemical Problems* has been prepared by Dr. *J. P. Grabfield* and Mr. *P. S. Burns*, of the Massachusetts Institute of Technology (Heath). The problems are classified according to the chemical principles on which their solutions depend. These principles are stated briefly at the head of each section, and the method of solving the problems is illustrated. The latter half of the volume is made up of examination papers, which consist partly of problems and partly of questions.

The three introductory lectures on *The Science of Thought*, by Prof. *F. Max Müller*, and the correspondence on "Thought without Words," all of which has been published in "The Open Court," are now issued in book-form (The Open Court Publishing Company, 75 cents). The three lectures deal with "The Simplicity of Language," "The Identity of Language and Thought," and "The Simplicity of Thought." In the second of these the author sets forth his doctrine that it is impossible to think without words, which provoked the correspondence that is appended. The writers of these letters are Prof. Müller, Mr. F. Galton, the Duke of Argyll, Mr. George J. Romanes, and others.

It will be pardonable to give a little space to *Law of Heat*, by Mrs. *Maria R. Hemiup* (The author, Geneva, N. Y., 75 cents), with the view of dissuading others from wasting time and money as she has done in promulgating impossible theories in science. Twenty years ago Mrs. Hemiup hit upon a theory to account for the bursting of containing vessels by freezing water, differing from the one commonly accepted. The present volume consists of her original newspaper article stating the theory, with some

correspondence about it, several quotations from eminent physicists, which she imagines support her theory, and a lot of irrelevant matter. Her screed is a "terrible example" of the way untrained persons form conclusions about scientific matters in absolute defiance of the scientific method of investigation. She says, "I assume that heat always causes bodies to expand, and that cold always causes bodies to contract, but never expand." Again, "I claim that cold water is always more dense than that of a more elevated temperature, and can not rise upon the surface of that which is warmer." Not a measurement nor a test of any sort does she bring forward in support of these assumptions, and, of course, can not, for her statements are flat contradictions of readily demonstrable facts. Further, she says, "As electricity is diffused throughout all space, it pervades water to a certain extent, and it always remains in a latent state except it is excited to action by some disturbing influence. And, again, as cold increases in temperature the water increases its density, and when it reaches the freezing-point it condenses to that extent that the pressure and friction excites the electricity to heat and converts little particles of ice into steam, which moves with great velocity and power; as the steam rushes out the cold air rushes into the little voids and takes the place of the steam, which causes the report called cracking of the ice. . . . It is first little particles upon the surface that are condensed into ice, and they would instantly sink if they were not arrested in their course and rendered light by the above-mentioned process." Has Mrs. Hemiup ever observed any one of these phenomena? Has she ever detected an electric current in a dish of freezing water with the galvanometer? Has she ever collected any of the little puffs of steam as it escaped from the forming ice? Has she ever seen, either with the naked eye or the microscope, the first-formed little particles of ice floating free on the surface of the water? Other people have seen the first ice-particles attached to the sides of the containing vessel or the shore; hence it can not be true that "they would instantly sink if they were not arrested in their course" by the action she describes. The letters about her theory which she has extracted from prominent scientific men are no indorsement of it, but are either politely non-committal or frankly opposed to her view. She gives the reader no reason to believe that she has ever performed a single experiment to test her supposition, or that in the twenty years or more during which she has speculated on scientific subjects, she has found out what valid evidence is, or what makes a hypothesis tenable. The effect of such a publication is harmful if it falls into the hands of persons whose common sense is not of the robust type, for it is sure to increase any tendency to foggy thinking which the reader may have.

The second annual report of the *Photographic Study of Stellar Spectra*, conducted at the Harvard College Observatory, and constituting the Henry Draper Memorial, relates that the additional facilities provided by Mrs. Draper have permitted a considerable extension of this research during the past year. The 11-inch refractor belonging to Dr. Draper, and an 8-inch photographic telescope, have been kept at work throughout every clear night. The 28-inch and 15-inch reflectors constructed by Dr. Draper have been moved to Cambridge, and the first of these instruments will probably soon be employed regularly. Four assistants take part in making the photographs, and five ladies have been employed in the measurements and reductions. The catalogues of spectra of bright and of faint stars, and the detailed study of the spectra of the brighter stars, will be finished, except for about one quarter part of the sky, which is too far south to be conveniently observed at Cambridge, in about a year, and it is proposed to then send an expedition to the southern hemisphere to complete the work to the south pole. The 28-inch reflector will be used for observing faint stellar spectra.

Bulletin No. 3 of the New York State Museum is an account of the *Building-Stone in the State of New York*, by *John C. Smock* (Albany, State Museum). All the large quarries were visited, to obtain material for this paper, and information was obtained also from quarry-owners and managers. The Bulletin comprises an account of the geological position and geographical distribution of building-stone in New York, and descriptive notes of quarry districts and quarries.

These notes give the location of each quarry, the character and position of the rock, manner of working, uses of the product, etc. The results of tests to determine the structure, hardness, and comparative value of these stones are deferred to another Bulletin.

Studies from the Biological Laboratory of Johns Hopkins University, Vol. III, No. 3, contains papers, based on experiments, with plates for illustration, "On the Laws of Muscular Stimulation and Contraction," by George T. Kemp; and "On Tetanus and the Velocity of the Contraction Wave in Striated Muscle," by John P. Cambell.

In a letter to the Prince of Boncompagni on *Various Points in the History of Mathematics*, which is published at Rome and Paris in French, M. Charles Henry discusses the problem of inscribing a triangle within a circle, as proposed in Ménon; the origins of the planetary signs and the Arabic numerals, and a number of other problems that have engaged the attention of students at various times.

The eight lectures on *The Social Influence of Christianity*, delivered by *David J. Hill*, LL. D. (Silver, $1.25), before the Newton (Mass.) Theological Institution in 1887, have been issued in book-form. The purpose of these lectures is to show how much and in what way Christianity has improved the character of our civilization. In the first lecture the nature of human society is discussed; the second is a summary reply to the question "What has Christianity done for Society?"; and the other lectures deal respectively with the relations of Christianity to the problems of labor, wealth, marriage, education, legislation, and repression. Doubtless some readers would be inclined to ascribe to other causes a part of the effects which the author credits to Christianity. In connection with the pictures which he gives of past progress, the author frequently expresses his opinions, or presents arguments, on sociological questions which are to be decided in the future. The book is methodical in arrangement, scholarly in tone, and readable in style.

The Realities of Heaven, eight lectures by the Rev. *T. F. Wright* (W. H. Alden, Philadelphia, 40 cents), is an exposition of the doctrine of resurrection and immortality, from the point of view of the Swedenborgian or New Church.

Opposite in point of view from the two preceding volumes is *The Bible of Nature*, by *Felix L. Oswald* (Truth-Seeker Company, $1). This is a spirited effort to state the principles of a religion of Nature, pointing out incidentally many ignorant, cruel, and revolting practices that have gone on under the authority of Christian churches. "The religion of the future," says Dr. Oswald, "will preach the gospel of redemption by reason, by science, and by conformity to the laws of our health-protecting instincts." Its principles as here set forth are comprised under "Physical Maxims," viz., health, strength, chastity, temperance, and skill; "Mental Maxims," viz., knowledge, independence, prudence, perseverance, and freethought; "Moral Maxims," viz., justice, truth, humanity, friendship, and education; and "Objective Maxims," viz, forest-culture, recreation, domestic reform, legislative reform, and the priesthood of secularism. The author sets forth the promptings of our normal instincts in regard to each of these matters, states the penalties of neglecting such promptings, and the rewards of conformity to them, with suggestions for reforming the present condition of society.

The author of "A Modern Zoroastrian," Mr. *Samuel Laing*, has issued a pamphlet entitled *Agnosticism and Christianity* (Watts & Co., London), in which he debates the question whether the two subjects of his essay are reconcilable. With that form of Christianity which disregards theological theories, and consists in imitation of the character of Jesus of Nazareth, he says agnosticism may well join hands, but that many of the harsh and incredible doctrines of the Old Testament and the churches may be, and are becoming, neglected by both Christians and agnostics. He does not believe that the loss of faith in a system of rewards and punishments in a future life would be a death-blow to morality, for the reason that, by the evolution of the human race, morality has become instinctive in civilized communities. He states briefly the "philosophy of polarity," which he has found most satisfactory, and closes by saying that the duty of a man of the nineteenth century being to follow truth at all hazards, he will find himself

constrained to adopt the scientific theory of the universe. But he must show "that the larger creed leads to a larger life; that it makes him more liberal and tolerant, more pure and upright, more loving and unselfish, more strenuous, as becomes a soldier fighting in the foremost ranks in the campaign against sin and misery; so that, when the last day comes, which comes to all, it may be recorded of him that his individual atom of existence left the world, on the whole, a little better, rather than a little worse, than he found it."

The latest attempt to design an ideal republic is contained in *Looking Backward*, by *Edward Bellamy* (Ticknor, 50 cents), which has the form of a story about a Boston young man who went into a trance for over a century, to recover consciousness among the family of a retired physician with a charming daughter. Stripped of its narrative dressing, the author's plan for reorganizing society is, that the people manage the whole industry of the country through the government. Each individual contributes to the common labor all he can of the kind of work he is best fitted for, and each draws from the public storehouses an equal share of goods. The saving of misdirected effort under this system makes it possible for all to be mustered out of industrial service at the age of forty-five, having entered it at twenty-one, after a liberal education. Houses and land are rented from the government. Money has no function. Accumulations of personal property become burdensome the moment they exceed what adds to the real comfort. The dread of want and desire of luxury being eliminated, the motives relied on to draw out the best efforts of the citizens are honor, patriotism, and the sense of duty. For the first three years after persons reach the industrial age they are assignable to any occupation, which makes all work of equal honor, and gives a prodigious impulse to the invention of labor-saving devices. The classes deficient in body or mind are regarded as members of the same family as their stronger brethren, and receive support and care as a right, not as charity. Hours of labor are less in the more disagreeable and laborious occupations, so as to make all equally attractive. Women are organized as an allied force in the industrial army, and employed for a few years in occupations suited to their sex. They have a world of their own, instead of entering into an unnatural rivalry with men. Marriages are contracted only from inclination or sexual selection. Most of the evils of all sorts which we at present deplore are eliminated by removing the conditions which put a premium on baseness.

The alcohol question is treated in a liberal but earnest manner by *G. H. Stockham*, M. D., in his little book entitled *Temperance and Prohibition* (The author, Oakland, Cal., 75 cents). Dr. Stockham gives a sketch of the temperance movement, accounts of the making and adulteration of alcoholic beverages, and a statement of the observed physiological action of alcohol. He includes also a summary of the liquor laws of Great Britain and America, with a chapter on prohibition, and one on suggested remedies for intemperance. He condemns prohibition as being ineffectual and tyrannical, and condemns also the licensing of saloons, as encouraging drunkenness and crime. He thinks a great step in the right direction would be to grant licenses only for the sale of beer, cider, and light wines to be drunk on the premises, and for the sale of spirits not to be drunk on the premises. He would be glad to see closer restrictive measures than these when society has been educated up to the point of supporting them.

Modern Speculation is an address by *M. W. Quick*, of Titusville, Pa., before the New York State Grange, January 24, 1888. The address points out the evil effect of gambling in agricultural produce on the prices of such articles, and asks the support of farmers in securing legislation to prevent fictitious sales of agricultural commodities. The pamphlet contains also the text of a bill having this object, with answers to objections, and explanations of the terms used on the exchanges.

A number of documents important for students of American and English history are made readily accessible in the *Old South Leaflets* (Heath, 5 cents a copy; one hundred copies, $3). They are pamphlets of twelve to twenty pages, without covers, and the General Series at present comprises the follow-

ing thirteen numbers: 1. Constitution of the United States; 2. Articles of Confederation; 3. Declaration of Independence; 4. Washington's Farewell Address; 5. Magna Charta; 6. Vane's "Healing Question"; 7. Charter of Massachusetts Bay, 1629; 8. Fundamental Orders of Connecticut, 1638; 9. Franklin's Plan of Union, 1754; 10. Washington's Inaugurals; 11. Lincoln's Inaugurals and Emancipation Proclamation; 12. "The Federalist," Nos. 1 and 2; 13. The Ordinance of 1787.

A gossipy little book is *From Lands of Exile*, by *Pierre Loti* (Gottsberger, 90 cents), consisting of letters written by a French naval officer from Annam and neighboring stations, with a story about "An Old Salt" and his daughter.

A rival of Volapük for the office of the universal language is presented by *Alexander Melville Bell*, in his pamphlet entitled *World-English* (N. D. C. Hodges, New York, 25 cents). World-English is the English language unburdened of its chaotic spelling, and with this change Prof. Bell deems it better suited than any other language for international use, on account of its grammatical simplicity and its already wide diffusion. Another use for this simplified form of the language which he urges is in teaching children and foreigners to read the present form, or "literary English," which he does not seek to displace. Prof. Bell recognizes the same sixteen vowel-sounds as the American Philological Association does in its scheme for the phonetic writing of English, for, although he omits two of them from his list, he distinguishes them in his exemplifications. He clings to the peculiar English uses of the vowel-letters, which makes the step from a foreign language to World-English harder, and that from the latter to "literary English" easier, but he distinguishes the unrepresented vowels by the aid of diacritics, in agreement with the usage of other languages. He thus avoids new letters in representing the simple vowels, but introduces one for the diphthong known as "long *i*," while "long *u*" (as in *mute*) he resolves into *yu*. He proposes no less than nine new letters for unrepresented consonants, three of these being the initial sounds in *when* and *hue*, and the sound of *r* when not before a vowel—refinements of notation which the Association does not deem necessary. In the case of the "obscure" sounds of unaccented vowels, however, he agrees with the Association in not deeming a special marking necessary. If we must have new letters for six or nine consonants, by all means let us take Prof. Bell's, for they are the simplest and neatest yet devised. Six of them are simply *c*, *s*, *z*, *t*, *d*, and *u*, with the tail of *p* added; the others are slight modifications of *w*, *n*, and *r*. He retains *k* rather than *c* for the final consonant in *pack*. He makes an odd slip in one place, in giving *nation* and *vicious* as words containing the sound of *ch* in *church*; he also marks the *u* in *January* like that in *February*. He says that "the terminations in *certain*, *fountain*, *foreign*, *cottage*, *courage*, *language*, etc., are regularly contracted to *-in*, *-ij*, and are so written in World-English," but we believe most persons pronounce these syllables more like *-en* and *-ej*. Prof. Bell uses no capitals in World-English, and marks the accent, when this is not on the first syllable, by a vertical line after the vowel of the accented syllable. In the case of a diphthong, he puts the mark between the two letters, which is somewhat confusing. The above objections refer only to details, and the scheme as a whole is much preferable to the mixture of Roman letters and "visible speech" symbols which Prof. Bell proposed in "Science" in 1883. The appearance of World-English, Volapük, and the various other plans for simplifying our mediums of communication, are signs that language is coming to be regarded as a tool that may be improved without disrespect to our grandfathers.

In an essay on *Science in Secondary Schools*, which received a prize of fifty dollars, recently offered by "The Academy," *Charles R. Dryer*, M. D., says that the best branch of science with which to break up the memorizing habit acquired by the pupil in the primary school, and introduce him to observation and induction, is physical geography. After this should come physics and chemistry combined, then biology, and last geology. In biology and geology, he advises proceeding from the known to the unknown, to study first what is nearest, rather than what is structurally the simplest. The spirit which he would have dominate science teach-

ing may be gathered from a couple of his maxims: "Never teach with books what can be perceived in objects," and "Never require belief where seeing and understanding are possible."

Judge's Young Folks is the title of a new sixteen-page monthly periodical for children and youth, published by the *Judge* Publishing Company, at $1.50 a year. It contains entertaining stories and sketches by popular authors, colored and wood engravings, "What Little Folks are Wearing," correspondence, and puzzle departments.

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Bancroft, Hubert Howe. California Inter Pocula. San Francisco: The History Company. Pp. 828. $5.

Blair, Andrew Alexander. The Chemical Analysis of Iron. Philadelphia: J. B. Lippincott Company. Pp. 282. $4.

Bonham, John M. Industrial Liberty. New York: G. P. Putnam's Sons. Pp. 414. $1.75.

California, The, Florist's Monthly. Vol. I, No. 2. Florist Publishing Company. Santa Barbara and San Francisco. Pp. 16. 10 cents, $1 a year.

Chamberlin, Edwin M. Eight Hours the Margin of Profits. Boston: Frank K. Foster. Pp. 9.

Columbia College School of Mines. Summer Schools in Chemistry and Photography. Circulars of Information. Pp. 8 and 7.

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Hopkins, H. R., M. D., Buffalo, N. Y. The Relations of Mind and Body. Pp. 7.

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Levis, R. J., M. D., Philadelphia. The Traditional Errors of Surgery. Pp. 15.

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McGill University, Montreal. Annual Calendar. Faculty of Medicine. 1888–'89. Pp. 95.

Martin, H. Newell, and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. IV, No. 4. June, 1888. Baltimore: N. Murray. Pp. 72, with Plates. $1, $5 per volume.

Lowell, James Russell. The Independent in Politics. New York: G. P. Putnam's Sons. Pp. 27. 25 cents.

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Meyer, Isaac, translator. On Dreams, by Saint Synesios. Philadelphia. Pp. 36.

Michigan, Agricultural College of. Experiment-Station. The Jack Pine Plains. Pp. 8.

Ohio, Agricultural Experiment-Station, Columbus. Experiments in preventing Curculio Injury to Cherries; and Midsummer Remedies for the Chinch-Bug. Pp. 20.

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Remsen, Ira, Baltimore. American Chemical Journal. July, 1888. Pp. 84.

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Simmons, J. Edward, New York. The Higher Education a Public Duty. Pp 32.

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Taussig, F. W. The Tariff History of the United States. New York: G. P. Putnam's Sons. Pp. 269. $1.25.

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Vaughan, Victor C., and Novy, Frederick G. Ptomaines and Leucomaines. Philadelphia: Lea Brothers & Co. Pp. 316. $1 75.

Vuillemin, Paul. La Biologie Végétale (Vegetable Biology). Paris: J. B. Baillière & fils. Pp. 380.

Ward, Lester F. What shall the Public Schools Teach? Pp. 10.

Ward, Thomas Humphry. International Copyright in Works of Art. Pp. 37.

POPULAR MISCELLANY.

The Peabody Museum of American Archæology.—The Peabody Museum of American Archæology and Ethnology received, during 1887, more than 6,600 additional specimens, making 3,267 entries. The largest sent was a collection of 5,261 specimens, made in Lewis and Mercer Counties, Ky., and Adams County, Ohio. A small collection from Fort Berthold, Dakota, includes what is probably the best specimen of authentic—that is, free from the influence of the white man—Sioux pottery that can be obtained; and a wand, illustrating the use to which the singular perforated stones, known

as "gorgets" and "banner-stones," were applied. By the aid of a committee of ladies of Boston, the famous "Serpent Mound" in Adams County, Ohio, has been bought, with about sixty acres of land, put in order, inclosed, and made the central object of an attractive park. "The example," says Curator Putnam, in his report, "thus set for the preservation of the ancient works of this country, has already aroused others to action, and many individuals and societies, particularly in Ohio, are now urging immediate action to prevent the further destruction of our archæologic monuments in the States."

Origin of Lake Superior Iron-Ore.—R. D. Irving, studying the ferruginous schists and iron-ores of the Lake Superior region, has found both of the theories that have been put forward to account for them—that of an eruptive, and that of a sedimentary origin—inadequate. He proposes a new theory, that the rocks have been derived from original carbonates by a metastomic process, or by replacement of the original dolomitic or calcitic rock by siliceous and ferruginous substances. The various steps by which this process took place may have been as follow: 1. The original form of the beds was that of a series of thinly-bedded carbonates, interstratified with carbonaceous shaly layers, which were also often impregnated by the same carbonate. This carbonate was generally more or less highly ferriferous, though probably there were intermediate forms between it and dolomite. 2. By a process of silicification—which varied in degree—these carbonate-bearing layers were transferred into the various kinds of ferruginous rocks now met with in the region. 3. The iron thus removed from the rock at the time of silicification passed into solution in the percolating waters, to be redeposited in various places as it became further oxidized, thus making ore bodies and various impregnations. 4. In other places, instead of leaching it out more or less completely, the silicifying waters seem to have decomposed the iron carbonate in place, producing a magnesia silicate, or a magnesia-iron silicate, the excess of iron oxidizing imperfectly, and separating out as magnetite, and the excess of silica crystallizing finally as a minutely interlocked quartz ground mass. 5. The bodies of rich ore have probably had different origins in different cases. 6. Some of the silicifying process went on before the folding of the formations; but some also afterward. It is not supposed that this theory will not require modification in the future, but it is the one to which the author has been led, without being influenced by any preconceived notions, very gradually, during the growth of his experience with the minerals of the region.

How long one can remain under Water.—The length of the time during which a person can remain under water without choking—a subject on which exaggerated stories have been told—has been studied by M. Lacassagne. The author was favored with an opportunity to examine Captain James, a celebrated diver, whose exploits have excelled those of all his rivals. He pretended to be able to continue four minutes and fourteen seconds under water. He contended once in England for a prize which was offered to any person who could endure five minutes, but was compelled by a hæmorrhage of the nose and ears to rise at the end of four minutes. He had also swum under water during the same time a distance of one hundred and fifty metres. He was accustomed before plunging to expel all the air from his lungs and take a strong inspiration. In the water he swallowed on the average about a litre of the liquid. When he came out of the water he snorted enormously. In one of the experiments to which M. Lacassagne subjected him, the movements of the heart became slow, irregular, and feeble at the end of two minutes; and on his coming out at the end of two minutes and thirty-seven seconds, his face was congested and his eyes flushed. Important facts in the experiments were that in his full inspirations previous to plunging Mr. James swallowed air, and while under the water a considerable quantity of saliva; and that his respiratory movements did not cease during immersion, but continued ample and regular at the rate of twenty a minute, while the thoraco-abdominal cavity diminished at a gradual and regular rate. M. Lacassagne explains these circumstances by supposing that inspiration under water draws into the lung the air contained in the pharynx, which

in turn draws from the air which has been swallowed into the stomach. This organ becomes, then, in the diver, a reservoir of air. It is evident from these observations that if persons who have been trained to diving can not remain under water more than four minutes without exposing themselves to great dangers, drowning men who struggle and inspire water can endure so long only under extremely favorable circumstances. The lesson is also taught that divers should not inflate their lungs before plunging, but should swallow air, which then passing from the stomach to the lungs will support respiration during a definite period of immersion.

Exhaustion from Rowing-Contests.—Prof. W. P. Trowbridge has discussed, in a paper read before the New York Academy of Sciences, the question "whether the excessive training for long-distance boat-races and the violent and long-continued muscular and nervous exertions incident to these contests do not in reality result in unnecessary and hurtful exhaustion during a race, and frequently in permanent injury to the contestants." Prof. Trowbridge says: "The boat-race involves the action of all the muscles, those of the legs, arms, and shoulders, as well as of the back; and hence the demands on the heart and lungs are the greatest possible. The work which a rower performs in each minute of a four-mile race is easily calculated. The distance—21,120 feet—is traversed in about twenty-one minutes. The speed is therefore practically about 1,000 feet per minute. At this speed the resistance to the boat in the water is about 75 pounds. This resistance has been determined experimentally as well as theoretically in England, the average result being 75 pounds. The work per minute for eight men is therefore 75,000 foot-pounds, or 9,375 foot-pounds (4 2 foot-tons) for each man per minute. At the rate of 350 foot-tons in ten hours, the day-laborer performs work at the rate of only six tenths of a foot-ton per minute. The rower in the boat-race, therefore, performs work each minute equivalent to the work of seven strong laborers, or at the rate of nearly one third of a theoretical horse-power each minute during the race. The question now recurs: For how long should these extraordinary efforts be sustained? Four miles in distance and twenty-one minutes in time mark extreme limits of endurance according to all experience in boat-racing; and if races are practically decided at the end of the third mile, or whether they are so decided or not, the fourth mile is a test not of skill and muscular strength, but of the hearts and lungs of the crews. This is rather serious business. Is it quite rational to make the ultimate endurance of these vital organs in a dozen young men a matter of sport and amusement? It is hardly to be expected that any boat-crew will initiate a movement to reduce the length of course from four miles to three; to use an appropriate expression, they 'would die first.' Such a movement might be looked upon as a confession of weakness; but when the suggestion comes from an outsider it is made to all alike, and may at least be discussed with possible profit."

Sanitation among the Negroes.—At a Public Health Conference held in Louisville, Ky., Bishop C. C. Penick read a paper in which he says: "It was startling to the North and the South alike, when the census of 1880 showed the tremendous increase among the colored people, and the cry of alarm ran through the land lest in the near future the black should be the dominant race in this country. The world did not recognize the fact that the great source of Southern wealth had consisted in making the negro prolific. Everything that could be done was done to eradicate all the diseases threatening to interfere with this object. In short, a man's negroes were a man's money, and you may just rest assured that he looked after them." When the race was released from bondage, its momentum carried it up to those startling figures of the 1880 census—figures which Dr. Penick thinks we shall never see again, for there is no longer an intelligent class which has a direct pecuniary interest in the health of the negroes; the latter are leaving the plantations for the less healthful surroundings of the towns, and the enfeebling vices of the town are spreading into the country. In a pamphlet by Dr. G. B. Thornton, of Memphis, it is stated that, although the white population of that city slightly exceeds the black, yet in 1880 a fifth more blacks than whites died, in 1881 a fourth

more, and in the first nine months of 1882 a half more. In the back streets and alleys of Southern cities, where the colored people live crowded together, Bishop Penick says that one may see "squalor, degradation, dirt; green scum in the gutters, dammed with decomposing vegetables, and, it may be, interspersed with a stray cat or dog that came to his untimely end at some uncertain period of the distant past. It does not take a man who knows how to read a diploma in Latin to see that here are conditions most favorable for engendering diseases." During four years spent in Africa he observed that "in his native state and scanty clothing the African is the most cleanly person I ever met. As a rule, he bathes twice a day and oftener in warm water. Deformity among them is as rare as among the birds and squirrels here"; but, on the other hand, that "no sooner did I begin to put clothes on these people than their aversion to water as an external application began to manifest itself, and punishment had to be resorted to to compel those who used to be scrupulously clean to keep moderately decent." Besides the charitable motive for improving the sanitary condition of the negroes, there is another side to the matter. "In other words," says the bishop, "it is a matter of deep concern to every thoughtful man, even if he looks no higher than self-preservation, what kind of diseases cling to those who cook our food, nurse our children, make our beds, wash our clothes, and porter our sleeping-cars. We know that in all of these departments the colored race play a prominent part." The diseases arising from the filth of the back streets and alleys may thus be brought through the back door into homes whose sanitary condition gives their inmates a sense of security.

The Salt-Beds of South America.—The salt-beds on the west coast of South America, according to the description of Dr. Carl Ochsenius, occur in a narrow strip along the coast-line of the rainless district, rarely exceeding twenty-five miles in width. The district is bounded on the east by the Andes, and extends into the coast Cordilleras on the south. The author considers that, before the upheaval of the Andes, salt began to deposit in certain bays, which had been wholly or partially shut off from the sea by the gradual formation of an intercepting bar. Then, while the process of evaporation was still incomplete, the district was raised by volcanic action, and the mother-liquors from the salt-lakes eventually escaped, running down into the valleys, and, where they encountered no obstacle, reaching the sea. The coast Cordilleras acted as a barrier in the southern portion of the district; while in the northern part the liquors doubtless returned to the sea. The volcanoes which produced the upheaval exhaled immense quantities of carbonic-acid gas, by the action of which a portion of the sodium chloride in the mother-liquors was converted into sodium carbonate. The coast in this part of Chili is studded with small islands containing deposits of guano rich in ammonia. The guano-dust is carried by the prevailing west winds far into the country, where, on exposure to the air, at a warm temperature, it would gradually oxidize to nitrate, and, acting on the sodium carbonate, would form sodium nitrate, or Chili saltpeter.

Relics of the Chiriquians.—From the graves of the ancient inhabitants of Chiriqui, on the Isthmus of Darien, great numbers of relics in clay, stone, and metal have been obtained during the past thirty years. A collection of such objects, gathered mostly by Mr. J. A. McNeil, is now deposited in the National Museum. The Chiriquians seem to have been skilled in the working of metals. Gold, silver, copper, and tin—the latter in alloys with copper, forming bronze—are found in the graves. Gold is the most important, and is found associated with all the others in alloys or as a surface coating. The objects consist to a great extent of representations of life-forms, in many cases more fanciful than real, and often extremely grotesque. They include the human figure and a great variety of birds and beasts indigenous to the country, in styles resembling work of the same region in clay and stone. Gold, pure and in the usual alloys, was also used in the manufacture of other articles, such as bells, beads, disks, balls, rings, whistles, thimble-shaped objects, and amulets of varied shapes. Bells are more generally made of bronze, because, perhaps, of its greater degree of resonance. The great majority of

objects were formed by casting in molds. Hammering was but little practiced, excepting apparently in the formation of sheet-gold, which was probably an indigenous product. Repoussé work is not found, save as represented in the crimping and indenting of gold-leaf. Engraving and carving were not practised. It may be deemed certain that gilding, or at least plating, was understood.

Fish-ponds.—The making and maintenance of fish-ponds is one of the arts in which man—at least until within a dozen years past—has not advanced. It was better and more extensively cultivated in antiquity and the middle ages than now. And there is still no better authority on the subject than Bishop Dubravius, of Olmutz, of the sixteenth century. He advised a regular draining of ponds, and cropping them with vegetables and grain in alternation with the fish. He would have three ponds, with a three years' rotation of vegetable crops, grown and breeding fish, and fry, so that the proprietor would always have a crop of vegetables growing in one pond, yearling fry in another pond, and breeders with the fish fattening for the market in the third. Captain Milton P. Pierce, of the American Carp Cultural Association, recommends draining the ponds every spring as early as the weather will permit, to promote the growth of aquatic vegetation, and another draining in October for the purpose of assorting the carp. He uses three ponds, all at the same time for fish, but does not advocate the rotation and planting system of Dubravius. Opinions differ as to the expediency of allowing trees to grow along the margins of fish-ponds. They harbor insects and so contribute to the supply of food, but their falling leaves are litter and make the water unpleasant. Frank Buckland recommended the hanging of a dead cat or rabbit over the pond, to be a nursery for "gentles"—plainly maggots—which would fall into the pond and afford excellent food for the fish. The presence of ducks is of great advantage, for they dig up the mud in the bottom, exposing the organic life it contains, and also increase the insect-breeding capacity of the mud—all helping to furnish the fishes' dinner-tables. A similar effect follows allowing cattle to come and stand in the ponds. The ponds should not be too deep, and large ponds have several drawbacks which are absent from small ones. There are advantages and disadvantages about having a stream run through the pond; hence it may be well to arrange so that the stream can be turned on or carried around at will. A "collector"—a wooden box, four feet deep by five square, sunk flush with the pond, with a perforated inner box that can be drawn up—is a convenient appendage. When the pond sluice is opened, the fish will go into the deepest water, which is in this collector, whence they can be drawn out and sorted. The collectors also may supply the place of the deep retiring holes which fish are fond of resorting to. Some breeders furnish a hedge in the pond as a shelter. A fattening tank affords a convenient means of securing a constant supply of fish ready for the table and easy to be caught. To supply food for the fish, Herr Fruwirth, of Austria, has pools and ditches with stagnant water and aquatic plants, wherein all kinds of insects etc., breed, which he turns into the ponds from time to time. Dr. Kelsen, of Oxford, has discovered that the animalculæ bred in water containing decayed vegetable matter are eagerly devoured by the young fry. Captain Milton Pierce says that nursery ponds in good condition and provision will support from one thousand to fifteen hundred yearling carp per acre area of water. Stock ponds, in like condition, will support five hundred two-year-old carp per acre. Larger stocks should not be permitted. Only one kind of fish should be allowed in the pond at a time. Where there are many varieties, they come to little good, and eat one another up.

Watering the Floors as a Preventive of Coal-Mine Explosions.—Mr. W. Galloway, believing that coal-dust is a very active cause of mine explosions, and usually even a more important factor than gas, recommends watering or simply dampening the floors of mines as an efficient preventive of them. In support of his theory he cites the case of the explosion of the Pochin colliery, in November, 1884, where the flame, which had been very powerful, was found to have been arrested by a slight dampness—such only as was caused by the casual leakage

from a water-cask hauled over the spot four times a day—on one of the roadways. Systematic watering of one of the collieries in the Rhondda Valley has not only made it safer and cleaner, but also cooler and more pleasant to live in. The influence of watering the floor seems also to extend to the timbers and walls of the mine, which cease to give annoyance from the dust lying upon them, without being directly watered. When simple tanks on wheels are difficult or expensive to manipulate in the mines, they may be replaced by a system of pipes bringing water from the surface, or from a reservoir at a convenient height in the shaft, and distributing it at different points in the workings, in the form of a fine spray.

The Botocudos.—The Botocudos of Brazil are famed as one of the most savage tribes on the American continent. Mr. W. J. Steains, who met a number of them during his exploration of the Rio Dôce, describes them as hardly prepossessing in appearance, five feet four inches in average height, having broad chests—which accounts for the facility with which they can bend their bows—small rather than delicate feet and hands, lean but muscular legs and arms, and features bearing "a wonderful resemblance to the Chinese," with skins of all shades of color. The custom of wearing large lip and ear ornaments of wood is fast dying out. "A regular process has to be gone through before a Botocudo can boast of wearing a lip-ornament, say three inches in diameter, and what is more, it is a life-long process. When the Indian is about three or four years old its parents pierce a small hole in the center of its under lip and also in the lobes of its ears. Into this hole a small plug of wood is inserted about the size round of a pencil. In the course of a few weeks a larger piece of wood is made to take the place of the first insertion, and so on until the lip (having been thus stretched gradually) is capable of receiving a *botoque* (plug) of the dimensions mentioned above, viz., three inches in diameter. It generally happens that in course of time the lip, which stretches round the botoque just like an elastic band, splits. This action on the part of the lip, however, does not prevent the further wearing of the botoque. The Indian simply ties the two ends of his broken lip together by means of a small piece of imbira, or stringy bark, and thus mends the breakage in a way that is decidedly more useful than ornamental." The Botocudos live upon the nuts of two or three varieties of palm-trees, which, as they are hard, are chewed for old people and children by the women; and they usually live to a good old age. The men spend their days in hunting, fishing, and seeing to their bows and arrows, while the women look after the children, gather nuts and fruits, and do the hard work. Clothing is entirely unknown among them. Plurality of wives is allowed but not usually indulged in. The people have no form of government except that of a chief who has no real authority. They believe in a Great Spirit who has made the world, but offer no prayers or sacrifices. They think he is angry and are much frightened when there is a thunder-storm, and throw fire-brands into the air to appease his wrath. When a man dies, his ghost wanders about upon the earth, in pursuit of what he may catch, but benefiting those who have done him kindness while he was on the earth. They have a hazy idea of the evil one, and believe that he resides in the body of a certain screeching night-bird.

Life in the Islands of Greece.—According to Mr. J. Theodore Bent, who has visited them, the shepherds and their families of the Greek island of Karpathos "for the greater part of the year dwell in caves high up in the mountains and die in them like their goats, with this difference only, that their friends do not allow their bones to bleach in the sun, though they inter them without any religious ceremony; they wail over them a great deal, and wait for the religious part of the business until a priest chances to pass that way. For the three months of winter they reside in the village, which is composed of small homesteads or *mandras*, probably like that in which the herd of Ulysses dwelt in Ithaca. Each house is a low cabin, to enter which you have to stoop, and consists of one room only, where cattle and people live together. It is built of large stones without cement, and through the cracks the north wind whistles horribly. Across the roof is a beam the top of which serves as the cupboard. There is a place for fire, but no out-

let for smoke; some brushwood laid on stones is the family bed, and the floor in wet weather is inches deep in slush and filth. The summer spent in the caves and in the open air must be a delightful change from this. Sometimes you may see a serpent in these cottages, which is never disturbed, but is deemed the *genius loci*, just as in ancient days if a serpent was found in a house an altar was erected to it, and it was esteemed a symbol of happiness; and there are invisible serpents, too, they say, which bring good when blessed, but when driven away by neglect cause the destruction of homes; and thus they account for the Greek ruins in their midst. They look upon the green lizards which run over their walls with a very different eye. The idea prevails that it is from eating these that serpents derive their venom; so they kill lizards whenever they can, and it is thought that whoever succeeds in killing forty of them is sure to go to heaven, having saved so many men from poison. I visited many families in their mountain caves, which are deliciously cool in the summer heats, and the mud floors are scarcely ever dry. Stone benches are put along the sides covered with dairy produce; in one corner is the oven, where the new milk is simmering all day. When the family goes out to attend the flocks, a lot of prickly brushwood is placed at the cave's mouth; no other door is needed."

The Occidental Ant.—As described by J. D. McLaren, in the "Bulletin" of the Washburn College Laboratory of Natural History, the nests of the Occidental ant (*Pogonomyrmex occidentalis*, or Western bearded ant), seen from the outside, are bare, flat disks of earth, from three to six feet in diameter, with their center marked by a heap of pebbles, lime-nodules, sticks, and lumps of dried clay. The insects — who work in the evening, but not in the hottest part of the day or during storms—cut down all plants that spring up on the disk, carry seeds into the nest from the vicinity, and form, with the pellets of clay which they bring up from underground, and other solid lumps, a very hard and compact concrete pavement, which acts as a roof for the nest and sheds the rain. Some loose earth and a heap of sticks and pebbles are left around the holes, which serve as doors to the nest. During rain-storms this loose earth is easily pulled into the holes, so as to close them and keep out the rain. Digging into the nest, one finds a series of galleries, each from one to three inches below the other. In these galleries are some small piles of grass or weed seeds, with here and there a group of yellowish-white larvæ. The ants have a large, broad head, a small chest with two horn-like points projecting backward, and a small abdomen, and are, as a rule, chestnut-brown. They appear to be strict vegetarians. The small black ants build nests on the disks, and work among the Occidental ants in the greatest apparent harmony.

NOTES.

A PROPOSITION is on foot for forming vast reservoirs in the Rocky Mountains by erecting dams in the cañons to hold back the spring floods and store the water for use in the dry season in irrigating the arid lands of the plains. It is a similar scheme to that which was broached more than forty years ago to be applied to the ravines in the Alleghanies, for the purpose of furnishing the Ohio River with a constant supply. Major Powell, who is thoroughly acquainted with the region affected, considers the scheme entirely feasible, and believes that the expense, great as it will be, will amount to but a fraction of the value of the land that will be reclaimed. An appropriation of $250,000 for preliminary surveys is to be asked for.

THE Canadian Institute has sent out circulars inviting co-operation in an effort to collect data respecting the political and social institutions, the customs, ceremonies, beliefs, pursuits, modes of living, habits, exchange, and the devolution of property and office which obtain among the Indian peoples of the Dominion. As in the United States, there is danger of the opportunity of collecting and testing the facts relating to these traits soon passing away. Contributions to the philology of the Indian tongues and additions to their folk- or myth-lore will also be welcomed as heretofore. The schedule of inquiries embraces sixteen classes of facts, under which a considerably more minute amplification in detail is suggested.

A MARBLE medallion portrait of Dr. Thomas Davidson, the distinguished paleontologist, has been unveiled in the Geological room of the Free Town Museum in Brighton, England. Sir Richard Owen, who was not able to attend, sent a letter of regret, and Professor Judd wrote testifying to the skill and enthusiasm with which Dr. Davidson carried on his researches.

A TRIAL race was recently had at Tours, France, to determine the relative speed of different kinds of couriers. Four horsemen of the dragoons and hussars, four cyclists on cycles of different kinds, two trained dogs, and some carrier-pigeons, competed. The course was from Tours to Montbazon, 4,300 metres. The pigeons accomplished it in 5′ 35″; the hussars in 7′ 57″; the dragoons in 8′; the dog Brisefer in 8′ 8″, Turco in 8′ 38″; the bicyclettist (riding a velocipede with two small and equal wheels) in 7′ 5″; the bicyclist in 9′ 15; and two tricyclists in 10′ 30″ and 10′ 40″ respectively.

MRS. EMMA W. HAYDEN has given to the Academy of Natural Sciences of Philadelphia in trust the sum of $25,000, to be known as the Hayden Memorial Fund, in memory of her husband, the late Prof. F. V. Hayden. The interest of the fund is to be applied to the purchase of a bronze medal and a further money reward to be given for the best publication, exploration, discovery, or research in geology or paleontology. The determination of the award will rest with a committee suitably appointed by the Academy. The competition will be open to Americans and others.

ACCORDING to the calculations of Prof. Kirchhoff, of Halle, the Chinese language is spoken by 400,000,000 persons; Hindustani and English by 100,000,000 each; Russian by 70,000,000; German by more than 57,000,000; and Spanish by 47,000,000. French is seventh in order.

RABIES prevailed among the deer of Richmond Park, London, and made necessary the destruction of many of the animals. The character of the disease was determined by inoculating rabbits with it, and these animals died exhibiting the characteristic symptoms of rabies. The infected animals are transformed to fierce and savage beasts, almost rivaling the rabid horse in their attempts to do mischief. The disease begins with signs of mental hallucination, and develops, through aggressive rage, into paralysis, ending with death by failure of the heart. The macroscopic and microscopic appearances of the affected tissues reveal the usual lesions which are symptomatic of rabies, and thus determine the exact character of the disease.

The "rabbit-pest" in Australia is marching steadily onward to the north—not in search of new pastures, but, according to Mr. C. G. N. Lockhart, in answer to one of the animal's instincts. The buck-rabbit is disposed to kill all the young ones if he can get at them, and the does are aware of this propensity. Hence the does, when they find themselves pregnant, slip away from the males, and go on in the direction in which they have been advancing, which topographical incidents have determined shall be northwardly.

THE firemen of London are to be dressed in fire-proof clothing of asbestus, after a fashion that has already been applied in Paris.

WHY is it, as a succession of rain-gauges set up at the same place will show, that the quantity of rain falling on a given surface diminishes with the height? The explanation is suggested by W. Mattieu Williams that the temperature of the upper strata of the air being below that of the lower strata, the rain-drops gather moisture as they descend, and become much larger when they reach the surface than they were at any previous height above it.

Seal-skins, when worn by the seals themselves, are very different in appearance from those which have been fabricated into ladies' cloaks. The fur is not visible, but is concealed by a coat of stiff overhair, dull, gray-brown, and grizzled. This overhair has to be removed by a long, laborious process, and this work, according to the thoroughness with which it is done, largely determines the value of the skin. Skins from two to four years old weigh from five and a half pounds to twelve pounds. It takes three skins to make a lady's sack.

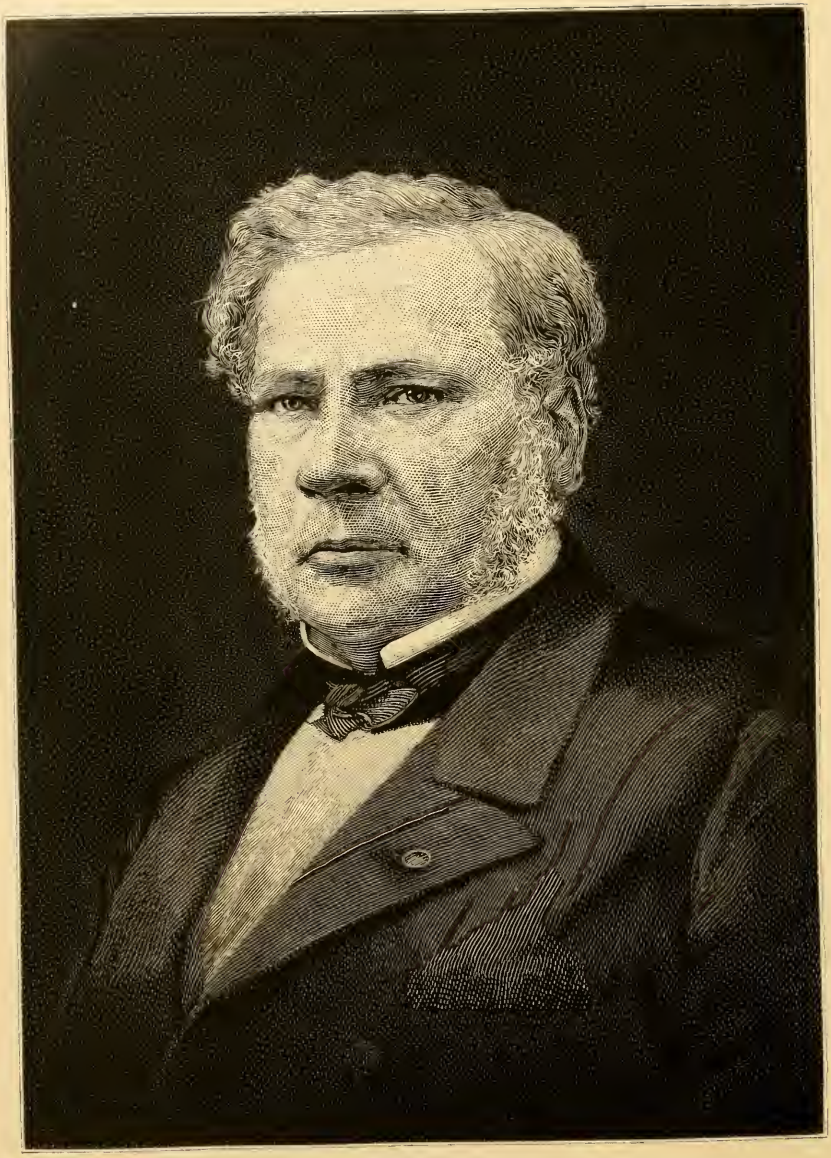
WHENCE, asks an English professor, came the men who inhabited the British Islands in preglacial times? Not from the east or south, for the remains of southern species of deer and other food-animals would have been found with theirs; whereas all such remains are of northern origin. Then, if men came down from the north, they must have gone up there in some previous age; and we have themes for curious speculations concerning the preglacial antiquity of man and polar climates.

The National Academy of Sciences has awarded the gold medal for an original investigation of meteoric bodies, provided for by the widow of Dr. Lawrence Smith, to Prof. H. A. Newton, of Yale University.

OBITUARY NOTES.

COLONEL JAMES STEVENSON, of the United States Geological Survey, and for many years connected with the Ethnological Department of the Smithsonian Institution at Washington, died in New York, July 26th, of heart disease. He was born in Maysville, Ky., in 1840.

HENRY CARVILL LEWIS, Professor of Geology at the Academy of Natural Sciences of Philadelphia, and in Haverford College, died in Manchester, England, July 22d. He had gone to Europe to remain three or four years in the prosecution of geological studies. It was among his immediate purposes to read a paper before the British Association, and afterward to visit Norway on a tour of geological observation.



JEAN BAPTISTE BOUSSINGAULT.

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THE RELATION OF THE SEXES TO GOVERNMENT.

By Prof. EDWARD D. COPE.

As is well known, the diversity of sex is of very ancient origin. It appeared in the history of life before the rise of any but the most rudimental mentality, and has at various points in the line of development of living things displayed itself in the most pronounced manner. Great peculiarities of sex structure are witnessed in the higher forms of life, as in birds and mammalia. The greatest peculiarity of mental sex character can only be seen where mind is most developed—that is, in man.

From what we know of sexual as compared with non-sexual reproduction, the advent of the former marked an important advance in the possibilities of progress. Reproduction by gemmation in non-sexual forms, and parthenogenesis in sexual animals, have a different result from sexual reproduction. In the former the characters of the single parent are reproduced with great fidelity. The cultivator who wishes to keep his stock true, uses buds and cuttings. On the other hand, seedlings are variable; because the offspring of two sexes inherit twice as many elements of difference as those of a single sex. Another great gain was secured in the development of a male sex. Being free from the disabilities imposed by maternity, the male could acquire a greater mastery over his environment than the female. His time would be less occupied, and his opportunity for physical exertion greater, and he could and would take a more active part in the struggle for existence. Hence, of the two sexes the male became the fighter and the provider, and necessarily, from the increasing muscular strength acquired in this more active life, the master of the two. He, therefore, became more specialized in some respects, particularly in those necessary to success in his various

undertakings. His part in reproduction became a specialization as compared with that of the female, which more nearly resembles the asexual method. So the male became the author of variation in species in two ways: first, by adding to the sources of inheritance; and second, by his own more numerous specializations.

In man the mental organization of the sexes expresses these facts in various ways. The sexual mental characteristics of men and women have been described by Lecky, Delaunay, Ladd,* P. G. Hamerton, and others, and with a unanimity that would of itself be authoritative if they did not confirm the belief of thoughtful observers generally. Woman is not only restrained by her reproductive functions from taking the same active part in the world's life as does man; but, what is more important, she inherits a greater disability from thousands of ages of equal and in some cases greater disability in the countless generations of man's animal ancestors. This nature is thoroughly ingrained, and is as permanent as any other part of her organism. In considering these mental peculiarities, it must be borne in mind that she inherits from her father as well as from her mother, so that she has benefited by the general progress of the race, but her relation to the male remains the same in each family taken by itself. Thus it has resulted that the women of a higher race or family will display superior traits to men of a lower race or family, even in some of the endowments which are the especial field of the male. And it is comparisons of this sort which frequently cause the question to be raised, whether the supposed superior rationality with which men are credited is ascribed to them justly. In the great variety of history and origin possessed by the people who are thrown together by our modern civilization, it must often happen that the women of superior lineage provoke favorable comparison with men whose ancestors have emerged from semi-savagery within a comparatively recent period. Nevertheless, in these cases also, sex qualities of mind are well marked, though more or less limited on the part of the inferior type.

It is the fundamental fact above stated that needs to be considered before all others, by those persons who believe that the present relations of the sexes, socially and politically, can and should be improved. And the next fact to be considered is, that persons who do not undertake the special functions of sex are of secondary importance in the question. It is evident that the influence on future generations of persons who do not produce those generations is exceedingly small compared with the influence of the persons who do produce them; just in proportion as

* "Elements of Physiological Psychology," 1887.

acquired characters are in small proportion to inherited ones. In all influence that depends on physical conditions, that of parents immensely preponderates over that of all others. Hence, in the present paper the relations of parents will be considered rather than those of other persons. For the good of the race, the parent must have the first place in the mind of the legislator, and all other persons must occupy a position of subordinate importance.

In comparing male and female minds we should take them at their best and not at their worst. We should take real livers and not pretenders; that is, persons who exercise their higher faculties, or who live up to their capacities. Very many men and women waste their higher faculties by disuse, but the married are less apt to live this aimless life than the unmarried. As there are persons who deny matters of ordinary observation, the actual differences of the minds of the sexes in general may be very briefly enumerated. We find in man a greater *capacity* for rational processes, a capacity which is not always exercised to its full. We find in men a greater capacity for endurance of the activity of the rational faculty. We find in men a greater capacity for work in those departments of intelligence which require mechanical skill of a high order. In the æsthetic department, we find incapacity more general than in women, certainly in the department of the æsthetics of the person. In woman we find that the deficiency of endurance of the rational faculty is associated with a general incapacity for mental strain, and, as her emotional nature is stronger, that strain is more severe than it is in man under similar circumstances. Hence the easy breakdown under stress, which is probably the most distinctive feature of the female mind. This peculiarity, when pronounced, becomes the hysterical temperament. But in all departments of mental action that depend on affection or emotion for their excellence, woman is the superior of man; in those departments where affection should not enter, she is his inferior. I think that most of the peculiarities of mind of the sexes may be traced to these first principles. The origin of these leading differences is not difficult to trace to the different functions of the sexes in the family relation, emphasized by repetition throughout the long ages of vertebrate, mammalian, and human history. Beginning with the maternal instinct, woman has become, by constant exercise, a being of affections. Her long protection by the male has reduced her capacity for defense; while the mastery by him has accustomed her to yielding, and to the use of methods of accomplishing her desires other than force. There are apparent exceptions to these definitions, but they are generally more apparent than real. For one of the characteristics of the female of man, acquired by long practice, is a capacity for keeping up the appearance of possessing qualities in which she is

more or less deficient. A ready capacity for acquisition of knowledge, and skill in language, are important contributors to this result.

It would seem, then, that Nature has marked out very clearly the relative positions of the sexes of man. This relation is beneficial not only from a natural but also from a social standpoint. The sex affection or passion has the greatest influence in compelling evolution of unwilling lives, and of driving where nothing can lead. The best emotions are aroused in the man who finds a woman dependent on him for support, and the infant's breath will awake that woman to serious thought and exertion who never had a serious thought before. Nor is the mutual benefit confined to the earlier days of the relation. It has been said elsewhere:* "While the interests of the members of the same sex often bring them into collision with each other, those of opposite sex can not normally do so. While the contests of the members of the one sex are the active agent in evolution by rivalry and force, the relations of opposite sex furnish the inducement to progress offered by mutual admiration and pleasure. Among mankind the necessity of pleasing and of inspiring the respect of the opposite sex has a great deal to do with the becoming pleasant and respectable."

The functions of the sexes being, then, different in society, as in nature, the question arises, To what extent should they perform identical functions? This question is pressed upon us to-day, and demands have arisen that woman should compete with man in all the forms of human activity, and should even have a hand in the government, whether constitutional or monarchical. The object of the present essay is to enumerate a few practical points with reference to these questions.

So far as regards cultivation of the mind, there can be no doubt that women should have all the facilities that are open to men. As the mothers of the human race, they should be deprived of no opportunity for development. The education of girls should be pushed as far as is consistent with good health. Had the education of women been encouraged earlier in human history, the general intelligence of the species would have been at a higher point to-day.

The competition with men by women in the pursuit of a livelihood is a necessity wherever women so outnumber men that they can not all marry, and where polygamy is not practiced. It is compulsory, and questions of taste and feeling have to be put aside in considering it. And the same unbending necessity decides the pursuit in which woman fails and that in which she succeeds. In some she succeeds easily; in some she can never succeed.

* "The Forum," September, 1887, p. 53, "On the Object of Life."

Between these extremes lies a territory in which each case settles itself. But it will ever remain true that, for the normal woman, the home-life is both the easiest and the happiest.

When we come to the question of government, we reach a field in which the acts of men do not concern themselves alone, but exercise an important influence on the lives of others. Is woman by physical and mental constitution adapted to engage in the various duties and services required in the making and executing laws, and in the enterprises which nations find necessary in order to carry on their functions, and preserve themselves from internal and external enemies ?

It must be here premised that the progress of civilization has thus far emphasized and not diminished the peculiarities of sex. The civilized woman is more refined, more tender, more intelligent, and more hysterical than her savage representative. Her form is more different from that of the male, and her face more expressive of her distinctive character. There is good reason to believe that this development has been due to the increased immunity from the severity of the "struggle for existence" which woman enjoys in civilized communities, and the greater opportunity thus given her to develop her own especial excellences.

The first thought that strikes us in considering the woman-suffrage movement is, that it is a proposition to engage women once more in that "struggle" from which civilization has enabled them in great measure to escape; and that its effect, if long continued and fairly tried, will be to check the development of woman as such, and to bring to bear on her influences of a kind different from those which have been hitherto active. And it becomes an impartial thinker to examine the question more closely, and see whether investigation bears out these impressions or not. We inquire, then, in the first place, is government a function adapted to the female character, or within the scope of her natural powers ? We then endeavor to discover whether her occupation of this field of action is calculated to promote the mutual sex interest which has been referred to above, and thus to subserve the natural evolution of humanity.

In endeavoring to answer the first question we are at once met by the undoubted fact that woman is physically incapable of carrying into execution any law she may enact. She can not, therefore, be called on to serve in any executive capacity where law is to be executed on adults. Now, service in the support of laws enacted by those who "rule by the consent of the governed" is a *sine qua non* of the right to elect governors. It is a common necessity to which all of the male sex are, during most of their lives, liable to be called on to sustain. This consideration alone, it appears to me, puts the propriety of female suffrage out of the

question. The situation is such that the sexes can not take an equal share of governmental responsibilities even if they should desire to do so. Woman suffrage becomes government by women alone on every occasion where a measure is carried by the aid of woman's votes. If such a measure should be obnoxious to a majority of men, they could successfully defy a party composed of a minority of their own sex and a majority of women. That this would be done there can be no question, for we have a parallel case in the attempt to carry into effect negro suffrage in some parts of the South. We know the history too well. Intimidation, deception, and the manipulation of the count, have nullified the negro vote. How many Governors, Legislatures, and even Presidents have attained their positions in violation of the rights of the ballot during the last twenty years, we may never know. In times of peace and general prosperity these things have excited indignant protest, but nothing more. But when serious issues distract the nation or any part of it, frauds on the ballot and intimidation of voters will be a more serious matter, and will lead to disastrous consequences. We do not want to increase possibilities of such evil portent. Unqualified negro suffrage is, in the writer's estimation, a serious blunder, and woman suffrage would be another. And it is now proposed that we have both combined.

Immunity from service in executing the law would make most women irresponsible voters. But there are other reasons why the questions involved in government are foreign to the thoughts of most women. The characteristics of the female mind have been already described. Most men who have associated much with girls and women remember how many needed lessons they have learned from them in refinement and benevolence; and how they have had, on the other hand, to steel their minds against their aimlessness and pettiness. And from youth to later years they have observed one peculiarity for which no remedy has been yet found, and that is, a pronounced frailty of the rational faculty in thought or action. This characteristic is offset by a strength and elevation of the emotional nature, which shines with inextinguishable luster in the wife and mother. It is to this that man renders the homage of respect, admiration, and such devotion as he is capable of. But, are these the qualities for our governors? Men who display personal bias in ever so small a degree, unless accompanied by unusual merits of another kind, are not selected by their fellows for positions of responsibility and trust. Strong understanding, vigorous judgment, and the absence of "fear, favor, and affection," are what men desire in their governors; for only through minds of that character can justice be obtained.

On account of their stronger sympathies girls always think themselves the moral superiors of boys, who are often singularly

devoid of benevolence, especially toward the lower animals. Some women imagine, for this reason, that their entire sex is morally the superior of the male. But a good many women learn to correct this opinion. In departments of morals which depend on the emotional nature, women are the superior; for those which depend on the rational nature, man is the superior. When the balance is struck, I can see no inferiority on either side. But the quality of justice remains with the male. It is on this that men and women must alike depend, and hence it is that women so often prefer to be judged by men rather than by their own sex. They will not gain anything, I believe, by assuming the right of suffrage, that they can not gain without it, and they might meet with serious loss. In serving the principle of "the greatest good of the greatest number," man is constantly called on to disregard the feelings of particular persons, and even to outrage their dearest ties of home and family. Woman can not do this judicially. After the terrors of the law have done their work, woman steps in and binds up the wounds of the victims, and the world blesses both the avenger and the comforter.

In the practical working of woman suffrage, women would either vote in accordance with the views of their husbands and lovers or they would not. Should they do the former habitually, such suffrage becomes a farce, and the only result would be to increase the aggregate number of votes cast. Should women vote in opposition to the men to whom they are bound by ties sentimental or material, unpleasant consequences would sooner or later arise. No man would view with equanimity the spectacle of his wife or daughters nullifying his vote at the polls, or contributing their influence to sustain a policy of government which he should think injurious to his own well-being or that of the community. His purse would be more open to sustain the interests of his own political party, and if he lived in the country he would probably not furnish transportation to the polls for such members of his family as voted against him. He would not probably willingly entertain at his house persons who should be active in obtaining the votes of his wife and daughters against himself; and on the other hand the wife might refuse entertainment to the active agents of the party with which she might not be in sympathy. The unpleasantness in the social circle which comes into view with the advent of woman suffrage is formidable in the extreme, and nothing less than some necessity yet undreamed of should induce us to give entrance to such a disturber of the peace. We need no additional causes of marital infelicity. But we are told by the woman-suffrage advocate that such objections on the part of men are without good reason, and are prejudices which should be set aside. But they can not be set aside so long as human na-

ture remains what it is. Men may grant women anything but the right to rule them, but there they draw the line. Is it not on questions of rule that the wars of men are mostly fought, and will men yield to the weak what they only surrender to irresistible force? In the settlement of all questions by force, women are only in the way.

The effect of sexual discord is bad on both sexes, but has its greatest influence for evil through woman. While it does not remove her frailties it suppresses her distinctively feminine virtues. This suppression, continued for a few generations, must end in their greater or less abolition. The lower instincts would remain, the flowers which blossom on that stem would wither. No matter what their intellectuality might be, such women would produce a race of moral barbarians, which would perish ultimately through intestine strife. The highest interests and pleasures of the male man are bound up in the effective preservation of the domestic affections of his partner. Where these traits are weak, he should use every effort to develop them by giving them healthy exercise. As in all evolution, disuse ultimately ends in atrophy, and the atrophy of the affections in woman is a disaster in direct proportion to its extent. It may be replied again that woman suffrage carries with it no such probable result. But I believe that it does, unless the relations of the sexes are to be reversed. But it will be difficult to reduce the male man to the condition of the drone-bee (although some men seem willing to fill that *rôle*); or of the male spider, who is first a husband and then a meal for his spouse. We have gone too far in the opposite direction for that. It will be easier to produce a reversion to barbarism in both sexes by the loss of their mutual mental hyperæsthesia.

If women would gain anything with the suffrage that they can not gain without it, one argument would exist in its favor to the many against it; but the cause of women has made great progress without it, and will, I hope, continue to do so. Even in the matter of obtaining greater facilities for divorce from drunken or insane or brutal husbands than now exist in many States of the Union, they can compel progress by agitation. A woman's society, with this reform as its object, would obtain definite results. The supposition that woman would improve the price of her labor by legislation is not more reasonable than it is in the case of men, who have to yield to the inexorable law of supply and demand.

When we consider the losses that women would sustain with the suffrage carried into effect *bona fide*, the reasons in its favor dwindle out of sight. The first effect would be to render marriage more undesirable to women than it is now. A premium would be at once set on unmarried life for women, and the *hetæra* would become a more important person to herself and to

the state, than the wife, because more independent. The number of men and women who would adopt some system of marriage without obligation, would greatly increase. Confidence and sympathy between married people would be in many instances impaired; in fact, the first and many other steps would be taken in the process of weakening home affection, and there would follow a corresponding loss of its civilizing influences and a turning backward of the current of moral progress. The intervention of women into public affairs is to be dreaded also by those who desire peace among men. Both women and their male friends resent treatment for them which men would quite disregard as applied to themselves; and woman suffrage would see the introduction of more or less numerous women into public life. The extreme and irresponsible language used by Mrs. Stanton and Mrs. Lathrop at the last woman's congress in Washington effectively illustrate this aspect of the question.

The devotional nature of women must not be left out of the account in considering this question. While this element is of immense value to that sex and to society when expended upon ethical themes, when it is allied to theological issues it becomes an obstruction to progress of the most serious nature. Were woman suffrage granted, theological questions would at once assume a new political importance, and religious liberty and toleration would have to pass through new perils and endure the test of new strains. What the effect would be we can not foresee, but it could not be good. The priest would acquire a new political importance, and the availability of candidates would be greatly influenced by the question of their church affiliations.

Many objections would be nullified if women should vote under the immediate direction of their responsible male associates, except the one based on their exemption from the execution of the laws; but, should they so vote, woman suffrage becomes a farce, as it is to that extent where it now prevails. The very essential support given by women voters to polygamy in Utah is an illustration of this. In Wyoming men load up wagons with their women to drive them to the polls to *vote their own ticket,* as I have had the opportunity of seeing in that Territory; and so they would do everywhere. If they wished to vote otherwise, they might stay at home; and it is to be expected that women would sometimes wish to vote "otherwise."

What I have written does not include any reference to supposed inherent right to the suffrage or to any principles of representative government. This is because the view that suffrage is not a right but a privilege appears to the writer to be the most rational one, and because any system of government which tends to disturb the natural relations of the sexes I believe to be most

injurious. In the absolute governments of Europe the home is safe whatever else may suffer; but a system which shall tend to the dissolution of the home is more dangerous than any form of absolutism which at the same time respects the social unit.

What America needs is not an extension, but a restriction of the suffrage.

A LIVING MYSTERY.

By GRANT ALLEN.

I HOLD in my hand here a key to one of the greatest mysteries of life—the perennial mystery of birth and reproduction.

And yet you needn't be in the least afraid that the mystery or its solution involves any technical scientific language, or possesses any tinge of occult abstruseness. It is only a pea that I hold here before me, an ordinary small, round, yellow marrowfat, the seed of the commonest of garden annuals. Nevertheless, that familiar little object, which all of us have known all the days of our life, incloses in itself the entire solution of the riddle of birth. If we understand the pea clearly, we understand the whole science of biology. Let us ask ourselves first, exactly what it is, and then see how it helps us to comprehend the coming into existence of all the higher plants and animals.

The pea is, in fact, here as it stands, a whole embryo plant in a dormant condition, the product, so to speak, of a distinct marriage. More than that, it is a totally new individual, produced by the interaction of separate cells from two pre-existing individual pea-plants. And it is that fact—which it owns in common with every other seed—that gives it illustrative importance as an example of the mode of production of all higher organisms, animal or vegetable. We may use it to explain this fundamental mystery of advanced life, because the principles which govern its origin and growth are the same as the principles which govern the beginning of all other conspicuous plants or animals in the world around us.

If you bend down a branch of a rose-tree, and cover it with earth, it will take root—make a layer, as we say, and grow up apparently into a separate rose-bush. After it has rooted itself firmly in the damp soil, you can cut it off with safety from the mother-plant, and remove it or transplant it to another part of the garden, where it will form, to all outward show, a distinct individual. Similarly, if you take cuttings from a scarlet geranium, and plant them in pots, you can multiply your original specimens in different places to almost any desired extent. In many cases, Nature has even provided beforehand, as it were, for such purely

vegetative propagation of a particular species. In the tiger-lily, for example, the tiny bulbels, that spring from the axil of every leaf, fall off when mature, and form distinct or separate plants on the ground beneath. In other instances, suckers, offshoots, or scions are produced, sometimes underground, as in the Jerusalem artichoke, sometimes above, as in the potentillas and hawkweeds, all of which grow out, to all appearance, into plants like the one from which they originally separated themselves. Many plants produce long, creeping branches, which regularly and systematically root at the nodes. The runners of strawberries are a familiar example of this mode of growth; so, in a somewhat different way, are the eyes of potatoes, the small side-bulbs in certain forms of onion, and the long, underground suckers or scions of the twitch or couch-grass.

When we come to look a little closer, however, at the nature of such seeming reproduction, we can see at once that in none of these cases is a new individual—in the truest sense of the word—really produced: all that has been done is to split up the original single organism into a number of colonies, as it were, or component parts, all still retaining the primitive individuality in shape, color, and every other particular. The branch is a branch while it remains on the tree; it is still none the less a branch in all essentials after it has been severed as a cutting, and made to root afresh like a distinct plant, apart from the remainder of the primitive individual to which it belongs.* Gardeners and agriculturists are perfectly aware of the truth of this principle, at least as regards its practical aspect, for they take advantage of it freely in the case of varieties which, as they say, "will not come true from seed." A particular potato-plant, let us say, or a particular rose-tree, possesses certain individual points, which render it desirable in cultivation; and, instead of seeding it, by crossing with another individual, and taking their chance among the seedlings (in which the special peculiarities seldom reappear), gardeners prefer to divide and multiply the original individual to the utmost possible extent, so as to make sure of retaining all the strong points of the plant in question, undiluted by crossing. All the Marshal Niels in existence, for example, are, in the last resort, cuttings from a particular, individual French rose-bush; all the British-Queen strawberry-plants are offsets by runners from a single, exceptionally fine-fruiting seedling.

Take an instance which I see before my eyes this very moment as I raise my head from my temporary study-table on a North African hill-side. The date-palms, which form the wealth of the

* I do not mean herein to dissent from Mr. Herbert Spencer's views as to what constitutes an individual. The apparent discrepancy, rendered necessary by the conditions of popular explanation, will be fully got rid of a little further on.

Arabs of the desert, and one of which now waves its long boughs in the breeze before us, are all female; the male or pollen-bearing flowers of the date kind always grow on a separate tree; and as pollen is produced by them in vast quantities, it is not necessary in palm-groves to have more than a single male stem to some forty or fifty fruit-bearing individuals. The Arabs, therefore, never raise their palms from seed, as they can not make sure of the sex of seedlings; they take suckers from the root of a female tree, already known to be a good bearer of fine fruit; and these suckers not only follow the sex of the so-called mother, but also reproduce its special peculiarities of flower and seed in every respect. They can not fail to do so, indeed, seeing that they are part and parcel of the original palm, actual members of the self-same plant; just as the various branches of an apple-tree all bear the same kind of apples, or the boughs of a currant-bush all produce the self-same currants.

And now let us hark back, by way of contrast, to the case of the pea, which is a true, distinct, individual plant, the product of a veritable marriage union. Whence came it? Was it born from a pea-blossom? So, indeed, we mostly imagine; though very incorrectly. As well say that a child is the son of his mother, but not of his father, as that a pea is the seed produced by a pea-flower. It is nothing of the sort. The whole secret of sex and reproduction is bound up in this simple illustrative instance. The pea is the product of *two different pea-blossoms.*

The mere accidental fact that each pea-blossom had stamens and pistil in its own flower must not blind us to the truth of this underlying principle of cross-fertilization, which every pea exemplifies for us as truly as every date or every melon. In the date and the melon the flowers on one plant are all male or all female; on the pea-vine they are all hermaphrodite. But, none the less, they intermarry. What happened when the pea was first launched into life was briefly this: A row of peas grew in the garden of the Moorish villa that gleams in the sun on the hill-side opposite; and on one of these vines hung a particular white-winged blossom, which supplied the pollen for the production of this individual pea. On another vine hung a second flower, from whose midst protruded the pistil which was finally to grow out into the particular pod that contained my pea. 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 from the stamens, which formed a sheath or tube round its twisted style. Then he flew away to pea-flower number two, and, in his clumsy attempts to thrust his long sucker down its nectar-bearing throat, he brushed a lot of number one's pollen from his legs and breast on

to the ripe stigma or sensitive surface of number two's undeveloped pod. So much alone we can see for ourselves with the unaided eye of outer observation. How much more of the history of this matter will dissection and the microscope finally tell us?

Inside the keel or lower petal of the pea the young pod pushes out its style and brush-like stigma to meet the advances of the fertilizing bee. On the end of the style, at the inner surface, a group of delicate hairs protrudes from the stigma; and it is on these hairs that the bee casually and almost accidentally (so far as he is concerned) deposits the pollen-grains he has carried off from the brother-blossom. Forthwith, each pollen-grain, meeting with the sensitive surface of a sister-style, and recognizing its position, begins to emit a tube of highly vital matter, which bursts out from its side and seeks a vent to penetrate the pod in the exact center of the neighboring flower. Now the hairs, on whose tip the pollen-grain has been deposited, are tubular and hollow; and the pollen-tubes, running down the style along these pre-established routes, soon reach the little ovules, or undeveloped peas, that lie concealed in the pod within. There it is that the actual, intimate work of fertilization itself really takes place. The vital material of plant number one, laid by in the pollen, enters and mixes with the vital material of plant number two, laid by in the ovule; and from their intermixture and union, in the most physical sense, there springs at last the wonderful little object I see before me—the pea itself, a dormant plantlet, waiting only for heat and moisture to wake it into life, that it may grow into a new and separate individual pea-vine.

Now, note the importance of this act of fertilization. Unless the pollen had reached the ovules in the undeveloped pod, the tiny peas therein contained would never have swollen or developed into perfect seeds at all. The flower in that case would have withered on its stalk, and the pod would have dried up to an abortive and shriveled mass of empty membrane. It was the union of the pollen of one plant with the ovules of another that produced this entirely new individual, a compound and outgrowth, not of one but of two distinct pre-existing organisms. The vital material inside the bee is the vital material of the one, re-enforced and vivified by the diverse vital material of the other.

In order to understand the use and object of this peculiar provision of Nature, whereby every higher plant or animal is the product of two prior individuals whom we call its parents, we must look first more closely at the phenomena of ordinary vegetative growth, and thus see wherein this higher mode of reproduction differs essentially from that simpler and lower function.

All plants (roughly speaking) can produce from certain parts of themselves new leaves and branches; and each such leaf, from

the extreme theoretical and biological point of view, must be regarded to some extent as a distinct individual. Nevertheless, the entire colony of leaves, the herb, shrub, or tree, as we generally call it, has also a sort of complex individuality of its own; it is an organism in itself, containing various parts or members, such as roots, stems, leaves, and so forth, each performing distinct functions for the good of the entire complex body. Now, the plant goes on for a certain length of time producing leaves from its surplus material one after another; and, as long as fresh material is supplied, this production or growth seems in some cases to have hardly any distinct limit. Strawberries, for example, will go on sending out runners (which are merely branches with tufts of leaves at the end that root from time to time) almost endlessly. We have here an example of continuous non-sexual reproduction. There are in nature innumerable variations in the manner of such purely vegetative growth. Sometimes, as in deciduous trees, the leaves all fall off in autumn, and totally new ones are brought forth from buds in the succeeding season; sometimes, as in the potato, new shoots spring from swollen underground branches; sometimes, as in the crocus, small bulbs are developed as stocks on the top of the old one. But, whatever the variation, the central fact still remains the same: the leaves, stems, or branches thus put forth are, strictly speaking, parts of the same compound organism, asexually produced, not entirely new and separate individuals.

A plant, however, no matter how vivacious, can hardly go on living forever. Sooner or later, there is reason to believe, this purely vegetative growth fails. The original vigor of its constitution gets used up; the life and go of the plant become hopelessly weakened. This seems to be the case at the present day, for instance, with the cultivated potato, which has been propagated from the tubers almost exclusively for many years, so that the existing plants must be of immense age, and have grown effete and feeble for want of proper sexual renewal. How are plants which have thus reached their dotage to restore their youth? How are they to carry on to future years the life of the species?

Nature has answered this problem of life by the wonderful device of intercrossing. The organism, like every other machine, tends in time to wear out and decay. But, unlike other machines, it contains in itself (through the action of natural selection) the means for manufacturing its own successors.

The leaf, we saw, grows out from the leaf. If you cut a piece of the common cactus or prickly-pear, and drop it on the ground, it roots at once and grows up afresh into a full-grown cactus-plant. There are some leaves which, if hung up, produce other leaves and little plants from their edges; and everybody must

have noticed how the common stone-crops will grow and root from any little scrap or fragment or bit that falls by accident upon damp soil. If we go down to the very bottom of the matter, it is clear that the plant tends to reproduce itself, whole and complete, from every part of itself—tends to increase in its own shape, and repeat itself anew in fresh leaves and branches. Why is this? Well, such a tendency results necessarily from the fundamental principle of cell-growth. Every living vegetable cell containing chlorophyl is always producing within itself fresh vital matter of its own kind; and this vital matter, at last outgrowing the capacity of the mother-cell, pushes itself out through the cell-wall, and grows into a new cell like the one it left. And it does so in the very last resort in virtue of that curious chemical property of the stuff we call chlorophyl, whereby such chlorophyl, under the influence of sunlight, separates the carbon and oxygen of carbonic acid, and builds them up once more into living matter of the particular sort composing the plant in which it exists.

Given a chemical body which can so increase the sum-total of living matter, and there must needs result the phenomenon of growth. Living matter is always being made anew from the non-living. But observe that in each plant the material thus assimilated from the air (or rather the carbonic acid floating in it), and more remotely from the earth and water, is built up into the forms of the particular plant itself—becomes distinctively, not mere living matter in the abstract, but strawberry matter, or stone-crop matter, or cactus matter, or whatever else the individual plant may happen to be. In this we get the real secret of like reproducing like. It results as a corollary from the principle of assimilation. Most people see a mystery in the particular fact that offspring resemble parents, but they see no mystery in the general fact that the parent reproduces or renews the parts of itself from alien material. In reality, the final explanation lies on this deeper and more essential level. It is just as strange that a rose should put out fresh leaves and shoots as that its seed should grow up into a fresh rose-bush.

The true explanation seems to be, as Mr. Herbert Spencer long ago suggested, that each organism has an inherent physical tendency (of the nature of polarity) to complete its own organic form, in somewhat the same way as a broken crystal, placed in a solution of its own material, has a tendency to replace its lost portions. The organic type, in other words, resembles the crystalline in this—that the material of which it is composed, when left to its own internal forces, tends, under the free play of those forces alone, to arrange itself in a certain definite specific shape.

In time, however, every organism or colony of organisms seems to lose this primitive plastic power of producing fresh

parts out of its own material. Old age, as we say, comes on. And this is specially true of the higher and more complex organisms. The tree no longer puts forth new leaves; the plant no longer sends out fresh branches. Its individual vigor appears to be used up. Unless, then, some fresh stimulus can be supplied it from without, the plant must die, and the species thus must suffer extinction.

At this point, therefore, Nature steps in with a special remedy —the special remedy of cross-fertilization. The earliest and simplest form of this device is seen in certain algæ or pond-weeds, mere long green hairs that wave about like tresses in the water, and consist each of endless rows of cells growing out in single file like the beads of a necklace one from the other. But every now and then two of these algæ "conjugate," as biologists put it—that is to say, a cell of one bends over and unites with a cell of the other, the cell-contents (or protoplasm and chlorophyl) of one cell breaking through to join the cell-contents of its neighbor. The union thus effected seems to supply a fresh stimulus to growth: the two matters coalesce and combine, and a new and more vigorous alga springs up as the final result of this combination.

Now, in the higher plants we get exactly the same sort of combination, only far more complex in its mechanism and results. 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. As a rule, too, the flowers come at the end of the branches, and in many—indeed, in most—plants they form a terminal spike or bunch at the summit of the stem, as in the familiar instances of the hyacinth, the buttercup, the sunflower, or the grasses. In other words, as soon as the vegetative growth is beginning to slacken, the need is felt for "fresh blood," for the special stimulus or fillip to further exertion given by union with another individual.

For the purpose of bringing about the desired union, all the higher plants are supplied with special organs known as stamens and pistils. The pistils produce the embryo seed, which is, in fact, a tiny separate plant, whose development is arrested at a very early stage, *unless fresh material from a neighboring stamen is supplied to supplement it.* The stamens produce the pollen-grains, which are, in fact, free cells containing a large quantity of very vitalized matter capable of fertilizing and vivifying the embryo seed. When a grain of pollen is placed by any agency whatsoever —wind, an insect, or a camel's-hair brush, as the case may be—on a neighboring stigma, it sends out a pollen-tube which penetrates the ovary and at last enters into and coalesces with the embryo seed itself. The fresh material thus added to the embryo seems

to upset the dormant condition—allows the failing growth to continue. The seed swells, the fruit ripens, and a new plant is shed forth upon the earth, the product of two distinct prior individuals.

But if the embryo is not thus quickened, growth in it ceases altogether. The seed shrivels up, the pod does not swell, and no new plant is produced at all. It does not contain within itself the needful energy for further development. Supposing all the flowers on a pea-plant were thus to fail—supposing no pollen were ever to be carried from blossom to blossom—then that particular plant would wither and die out altogether, leaving no offspring at all behind to represent it.

In the case we have supposed, however, the flower *did* get fertilized, and the pea before me—a dormant but still a living plant—is the irrefragable proof that it actually did so. Now, in some instances, perhaps in this one, a flower gets fertilized with its own pollen. In such cases, as a rule, the fruit nevertheless swells out properly and the seed produces a young plant. How, then, are we to reconcile this apparent discrepancy with the general principles of sexual growth laid down above ? Well, we must recollect that in a certain sense each leaf is a distinct individual. Again, from the biological point of view the flower consists of modified leaves, some of them specialized to do duty as sepals, some as petals, some as stamens, and some as ovaries. Each of these is therefore in some sense an individual. In the entire community or compound organism, in other words, we may regard the stamens and ovaries as particular members, told off, like the queen-bees and drones in the hive, to fulfill the part of fathers and mothers, while the true leaves, like the workers, provide the food or material for growth. Thus, even in the same flower the stamens and ovaries are properly to be regarded as distinct individuals, capable of producing healthy offspring with one another, like the queen-bees and drones of the same hive.

Nature, however, does not stop here. The fundamental fact at the bottom of all fertilization whatsoever seems to be this, that where individual formative power fails it can be supplemented and set on foot again by an access of fresh formative power from without. Union is strength: what one can not do, two can. But the fresh fillip seems to be most distinctly felt when it comes not from another member of the same original colony—that is to say, from a stamen of the same blossom or of another blossom on the same plant—but from a totally distinct and separate colony, or, in other words and in more familiar language, from the flower on another neighboring plant. Where the parents are too closely related, it would seem, both are apt to have the same weak points, which therefore reappear in the offspring and vitiate it. But

deeper down even than that, since both belong to the same colony at the same period of failing growth, the impulse to fresh effort afforded by such a union would appear to be less; indeed, in some cases it is quite inoperative; whereas, when each comes from a separate plant, not only are the chances of diversity in constitution greater, but the constitutional fillip or stimulus to growth is more distinctly marked. Birth is a result of the union of unlikenesses.

Hence, while among the lowest and least developed flowers self-fertilization (or, to speak more correctly, fertilization of each ovary by its brother-stamens) is very common, among the higher and more specially adapted plants devices for promoting cross-fertilization, either by wind or insects, are almost universal. In some instances, indeed, the ovary can not be impregnated by pollen coming from the same flower—the fillip does not seem sufficient to promote growth, and the ovary touched only with pollen of a neighboring stamen remains to the end perfectly sterile. Truly distinct pollen is needed to quicken it. In other cases, though such incapacity does not exist, special arrangements have been made to prevent self-fertilization—the stamens and pistils do not mature together, or else they are so arranged in the blossom that contact of the pollen with the stigma is almost impossible. And in some of the very highest plants of all, the stamen-bearing and ovary-bearing flowers are distributed on totally distinct trees or bushes, thus affording the most perfect known development of the sexual principle—a sort of automatic compulsory exogamy, whereby each blossom must needs intermarry with a member of an entirely different colony.

For the same reason it will now, I hope, at once be clear why the offspring in every case resembles on the whole both parents equally. The various leaves which each rose-tree puts forth are exactly alike, and we don't expect them to be at all otherwise, because they are all similar products of the self-same active and formative energy. However much we may subdivide the parts of a plant, we look forward to finding its manifestations remain unchanged, as in the familiar case of cuttings, grafts, layers, suckers, bulbs, and runners. The different leaves, made of the same ultimate stuff, the new material of the species, resemble one another exactly as two parts of the same lump of clay or putty have similar characters; or exactly as the two halves of the same crystal rebuild their lost parts and renew their original shape alike when immersed in a mass of the same mother-liquid. So, too, we may well believe the undeveloped embryo or unfertilized seed potentially resembles in all things (as far as it goes) the mother-plant; but, as soon as it is fertilized by the pollen from its neighbor, it becomes in every portion of itself part and parcel of two previous

plants; or rather, the resulting new organism is the outcome of a compromise, perhaps even of a struggle for mastery, between all the parts or component elements of the two parent plants. Hence, in all species, animal or vegetable alike, the young on the whole tend to resemble both parents equally, but in different modes of combination, which give them each what we call individuality, and so make them really and truly new plants, not mere reissues of either parent form.

When I had written thus far on this present article, I laid down my pen for a little rest, and strolled out alone upon the dry African hill-side, a lower shoulder of the Atlas range, that stands opposite the villa whence I date these words. By a curious coincidence, as I rambled through the lentisk scrub, I happened to light upon a little bed of natural hybrid orchids, which so admirably illustrate the nature of this peculiar intermixture that I joyfully accepted them to point the moral with which I must close this long lay sermon. Numbers of a large and handsome yellow orchid grow on the slopes of that particular hill, and in and out among them spring members of another yet closely related species, dingier brown, and different in shape, disposition of parts, and general appearance. Some wandering bee, visiting a flower of the yellow orchid at this spot where I stood, had carried away on his head its 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, all of them more or less resembling in certain respects both parents. In most cases they had, to a great extent, the distinctive shapes of the brown kind, with a preponderating amount of yellow color. But among them all they presented every possible intermediate type between the two parent forms. It seemed to me that this accidental find exactly fitted in with the subject of my paper. We see here how each embryo seed, separately impregnated by a pollen-grain from another plant, grows out with a tendency to reproduce both ancestral forms equally, and how the conflict between the two tendencies, both of which can not fully be realized, produces in the end an individual compromise—a something which is not quite either, but which combines in varying and incalculable degrees the strongest points of both.

Unless I mistake, we have here the solution (suggested in the main by Mr. Herbert Spencer) for one of the deepest and most fundamental problems of all life, animal or vegetable—the problem of reproduction, heredity, and individual variation.

THE GROWTH OF JELLY-FISHES.

A CHAPTER IN THE NEW ZOÖLOGY.

By Prof. W. K. BROOKS,
of Johns Hopkins University.

II.

[*Concluded.*]

IN the first part of this article I described the life-histories of two hydroids: one, Liriope, in which each egg gives rise to only one jelly-fish, which is solitary and free at all stages of its existence, and without any power to multiply asexually; and a second species, Dysmorphosa, in which there is no limit to the number of adults to which a single egg may give rise, and in which the life-history is a complicated alternation of generations, with a sessile polymorphic hydroid stage from which the sexual jelly-fishes are produced by budding.

I shall now briefly sketch the more prominent features in the history of the process of specialization which has gradually evolved a complicated life-cycle like that of Dysmorphosa from one as simple and direct as that of Liriope. The parasitic jelly-fishes are peculiarly instructive in this connection. The genus *Cunina* includes a number of species which, while young, are parasites on other jelly-fishes. The free-swimming adult of one of them (*Cunocantha octonaria*) is shown in Fig. 9. It is quite

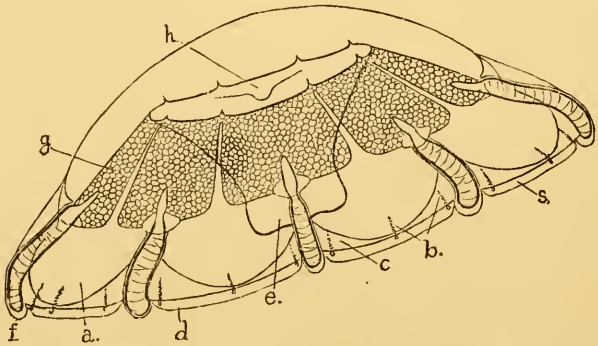

Fig. 9.—Side view of *Cunocantha octonaria*, slightly magnified, drawn from Nature by W. K. Brooks.

common upon the coast of Virginia and North and South Carolina. The adult is not a parasite, but as soon as the larvæ hatch from the eggs they make their way into the bell of another jelly-fish, and live there as parasites until they complete their development and assume the adult form. The jelly-fish which affords a home for these parasites is shown at K in Fig. 15. It is known as Turritopsis.

The hydra which hatches from the egg of the Cunina is free, like the hydra-larva of Liriope. It has a short globular body, and an enormously elongated proboscis, at the tip of which the mouth is situated (Fig. 10). It has four short tentacles which are turned backward away from the mouth, and are terminated by round knobs, which are used for clinging to the body of the Turritopsis, for as the parasitic larva sucks its food out of the stomach of its host, it does not need to use its tentacles for capturing living animals. As soon as it finds its way into the bell of a Turritopsis it fastens itself securely by its tentacles to its inner surface in the angle at the base of the stomach, where it is in no danger of being swept away by the current which the Turritopsis produces while swimming, and, once securely fastened, it bends down its long proboscis, passes it up through the mouth of the Turritopsis into its stomach, and sucks out the digested food.

Turritopsis is shown at K in Fig. 15; and Fig. 11, which I have copied from McCrady, the discoverer of this remarkable case of parasitism, shows the outline of the inner surface of the bell, and of the stomach of Turritopsis, with three of the parasitic Cunina larvæ in place, fastened by their tentacles, and with their mouths inserted into the stomach of their host.

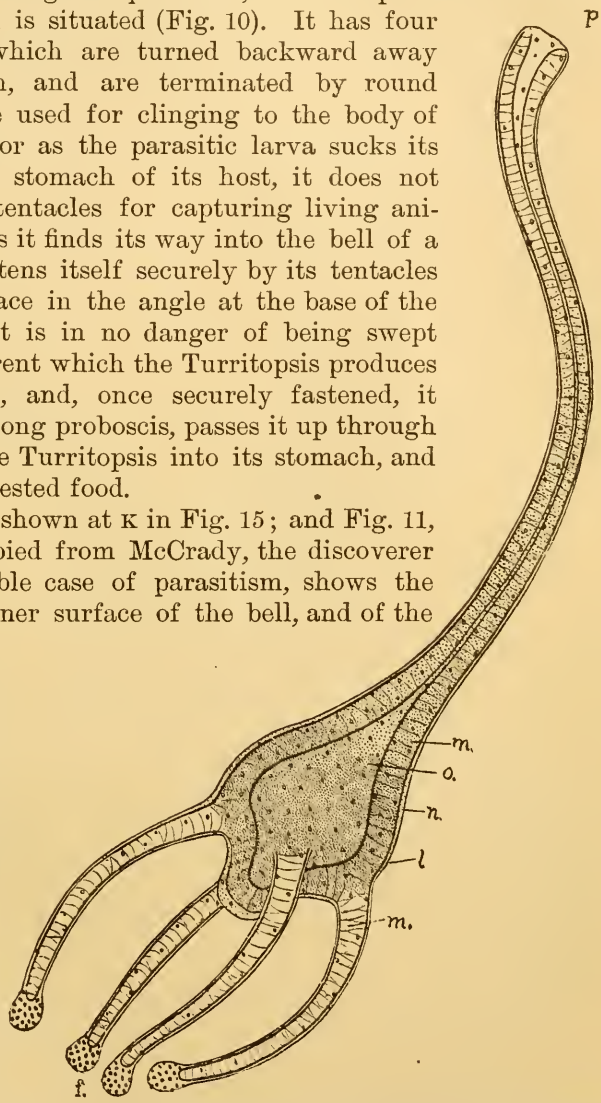

FIG. 10.—The Hydra, which hatches from the egg of *Cunina octonaria*, drawn from nature by W. K. Brooks: *o*, body; *p*, mouth; *f*, tentacles.

Thus protected by the bell, and supplied with abundant food, which it neither captures nor digests, but sucks, all ready for assimilation, into its own stomach, the larva has a very "soft thing," and is naturally in no hurry to complete its development or to seek its fortune in the open water. It grows rapidly, acquires more tentacles, and, as its stomach grows larger, and it becomes able to suck in and to assimilate more food than it needs

for its own growth, it gives rise to buds, which become parasitic hydras like itself, and remain attached to it and share all its advantages. The budding continues until a complicated colony of long proboscides, bodies, and tentacles is formed. A young colony of these larvæ is shown in Fig. 12, and an older one in Fig. 13.

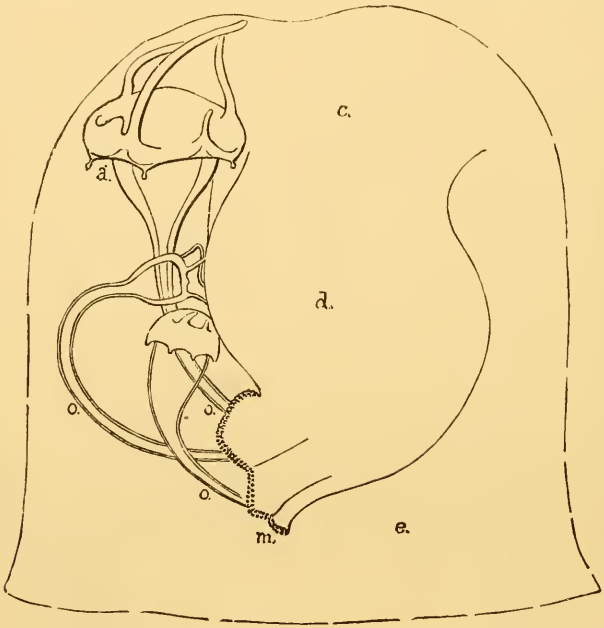

Fig. 11.—Outline of a Turritopsis, with parasitic Cunian larvæ, copied from McCrady.

The hydra larva of the Liriope is only a short transitional stage in the youth of the adult animal, but in Cunina the larval life has become vastly more important; and this is clearly due to the fact that it has found a home which is extremely favorable to it as a larva, an environment where all its wants are supplied, and where it enjoys so many advantages that the speedy acquisition of the wandering life and high organization of the adult is no longer desirable.

To all ordinary animals the period of infancy is full of danger. Young animals are encompassed on every side by peril from enemies, diseases, and accidents, and the prospect of long life increases enormously as childhood passes and maturity approaches.

Short infancy and rapid development are therefore, in ordinary cases, the conditions which are most favorable for the perpetuation of the species and the welfare of the individual: but this does not hold good of Cunina. The hydra stage has therefore been prolonged, and the larva has acquired the power to produce other larvæ to share its advantages. After a time, however, a flange or collar grows out from the body of each hydra, among the bases of

the tentacles, as shown at *e* in Fig. 13; and, folding down toward the mouth, gives rise to a swim-bell and bell-cavity. The larva is then set free, and it escapes into the water as a young jelly-fish (Fig. 14), with an enormous proboscis (*d*), a relic of its parasitic

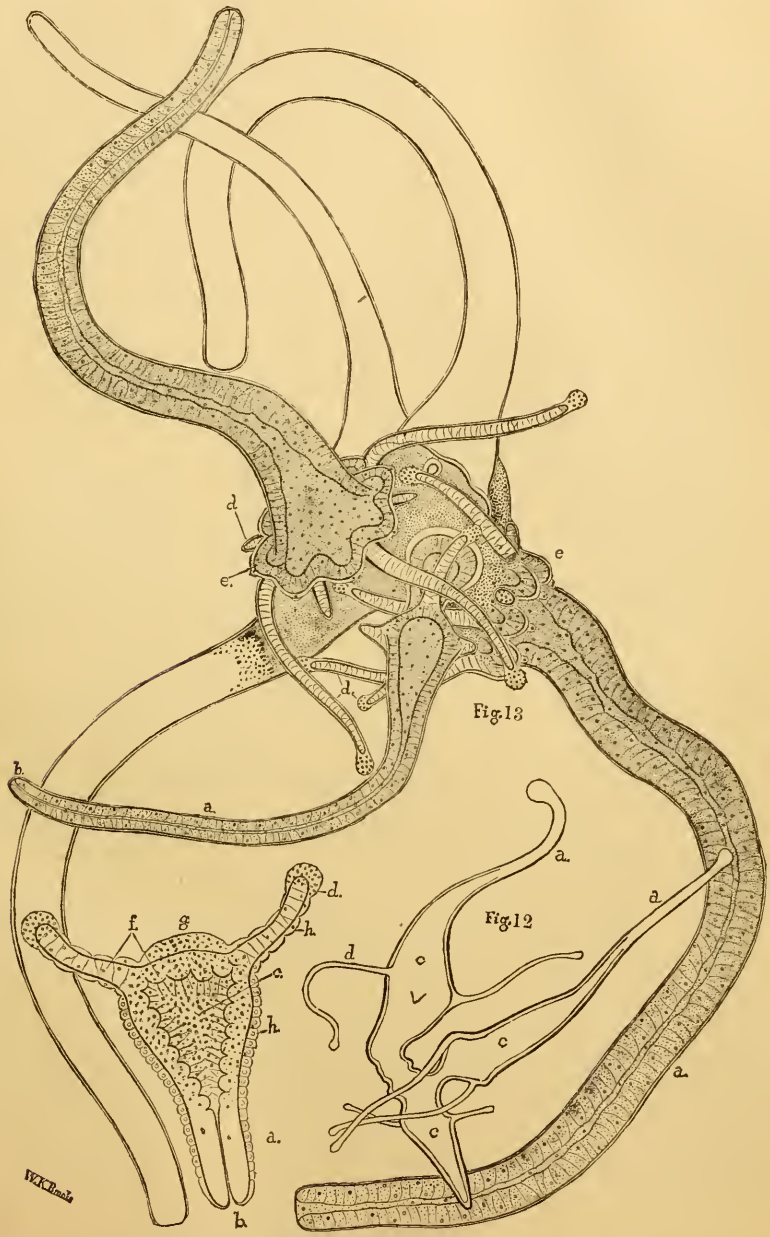

FIG. 12.—A colony of three young parasitic larvæ of Cunina.
FIG. 13.—An older colony, consisting of six Hydras, some of which have begun to become transformed into Medusæ.

life, and a small bell (*e*), which, however, grows very rapidly, so that the animal soon assumes the adult form, shown in Fig. 9.

The life-history of this species of Cunina is given in the following diagram:

$$\text{III. Cunina Octonaria.—Egg} = \text{Planula} = \begin{cases} \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \times \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \times \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \end{cases}$$

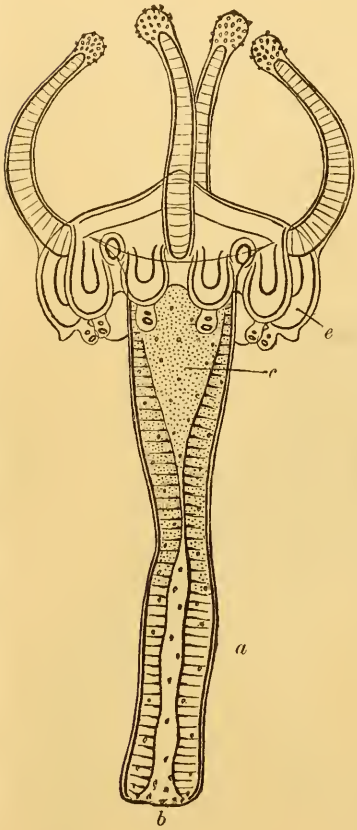

Fig. 14

The egg becomes converted into a planula, this into a hydra, and this into a medusa, exactly as in the case of Liriope, except that the case is complicated by the budding of new hydras, each of them destined to become a medusa, from the body of the hydra which hatches from the egg, during its parasitic life, and before it becomes a medusa. Each Liriope-egg produces only one adult, while the number of adults which may be derived from a Cunina egg is quite large, although every individual in the series ultimately becomes an adult, and multiplies by sexual reproduction.

In another species of *Cunina*, *Cunocantha parasitica*, a new complication is introduced, for the hydra which hatches from the egg never becomes a jelly-fish, but remains a parasite as long as it lives, budding off other larvæ which grow up into adults. Its life-history is like this:

$$\text{IV. Cunocantha Parasitica.—Egg} = \text{Planula} = \text{Hydra} \times \begin{cases} \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \\ \text{Hydra} = \text{Medusa} < \text{eggs.} \end{cases}$$

If the hydras which are formed by budding were to remain as hydras, like the one which hatches from the egg, and were to bud off jelly-fish, we should have a life-history which is exhibited by many species, and is shown in this diagram:

$$\text{Egg} = \text{Planula} = \text{Hydra} \times \begin{cases} \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \\ \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \end{cases}$$

Turritopsis, the jelly-fish, which is infested by the Cunina larvæ, has a life-history which is very similar to the one given in this diagram, with the addition of a slight but highly important modification.

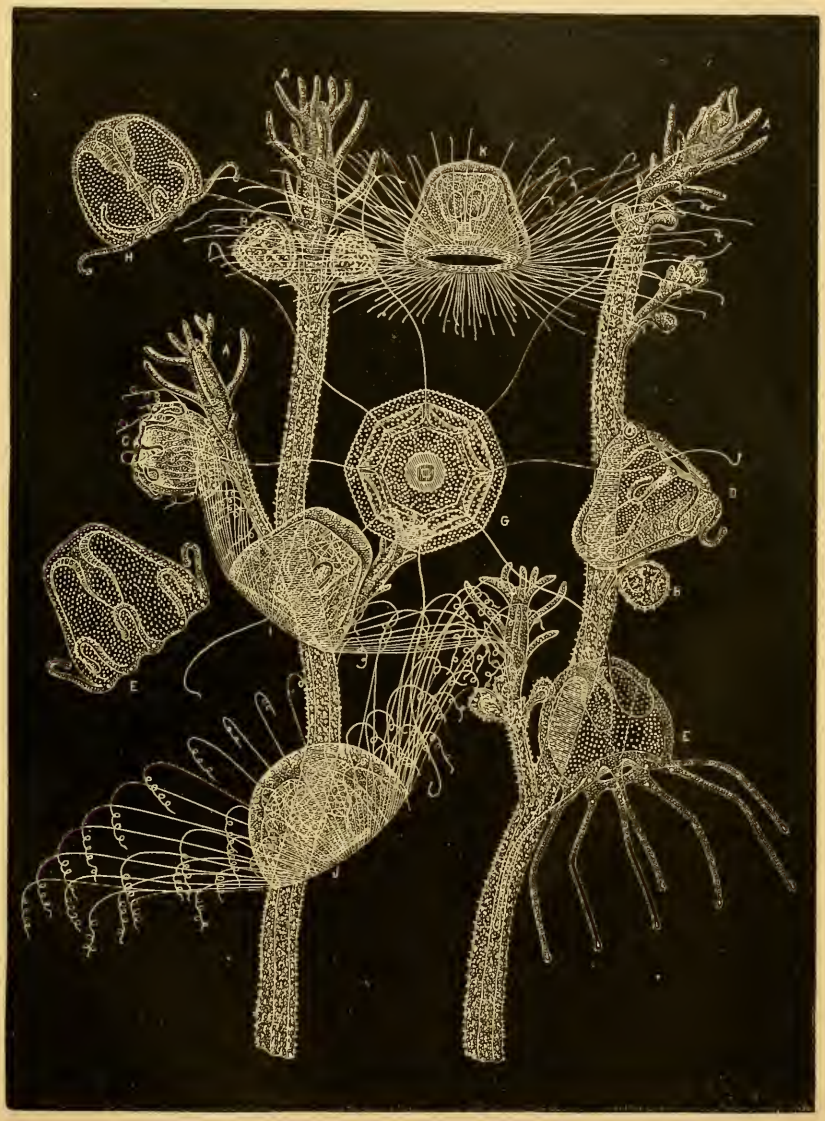

Fig. 15.—Turritopsis.

The planula is shown in the left-hand lower corner of Fig. 2. It soon attaches itself to some solid body and becomes a root, which goes no further, but, as shown in the right-hand lower corner of Fig. 2, soon produces a bud which becomes a feeding hydra. Multiplication by budding now goes on rapidly, in such a way as to

build up a branching, tree-like colony, with a feeding hydra at the tip of each twig. Two branches from one of these trees are shown in Fig. 15. Ultimately each of these hydras produces a number

Fig. 16.—Eutima.

of buds around the base of its body, as shown at B in the figure, and these buds ultimately become detached and grow up into the adult jelly-fish, K.

$$\text{V. Turritopsis.—Egg} = \text{Planula} = \text{Root} \times \begin{cases} \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \\ \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \\ \text{Hydra} \times \begin{cases} \text{Medusa} < \text{eggs.} \\ \text{Medusa} < \text{eggs.} \end{cases} \end{cases}$$

The life-history of Turritopsis is therefore like this, and the chain which connects the egg with the adult is broken three times, for the root, which is directly derived from the egg, goes no further, nor do the hydras which bud from the root become jelly-fish, and the latter form still a third set of individuals.

The larval life is long and important; the number of sexual adults produced by each egg is very great indeed, and the life-history is extremely complicated, but each one of the individuals is in the direct line of succession; for, while neither the root nor the hydras ever become converted into any higher form, the root produces hydras, and each one of these produces jelly-fish.

In the next species to be considered, a Eutima which is common on our coast (Fig. 16), another stage of complexity is introduced by the restriction of the power to bud jelly-fish to certain hydras, while others become specialized for nutrition. This specialization has come about gradually, and the various species of living hydroids exhibit all the steps in the process. In some species, as in Turritopsis, all the hydras perform both functions, and are alike in structure; in others, those which are placed at the tips of the branches and are best able to obtain food devote themselves to this purpose and produce no jelly-fish, while these are budded only from those hydras which are near the base of the colony. In some cases the two sets of hydras are alike in structure, but in other species the feeding hydras at the tips of the branches are very large, with capacious stomachs and long tentacles, while the reproductive hydras have small tentacles and mouths. In still other species, as in Eutima, they are true blastostyles, without mouths, and with rudimentary tentacles, and all the work of nutrition is performed by the feeding hydras.

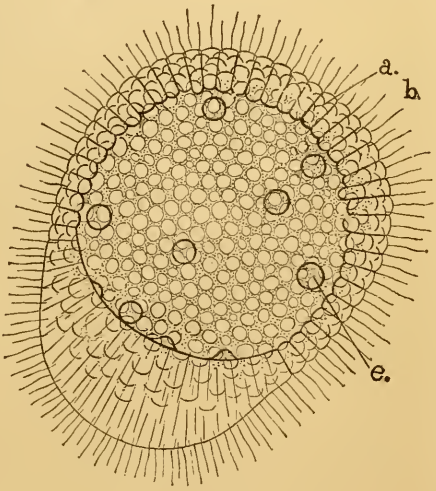

Fig. 17.

The planula of Eutima is shown in Fig. 17. After a short swimming life, it fastens itself to some solid body, and elongating, be-

comes a root (Fig. 18); and a bud, *m*, soon grows out from it to form the first feeding hydra, which soon acquires a mouth (Fig. 19, *l*) and tentacles, *i*, and begins to capture and digest food and to accumulate a reserve of nutriment, while the root continues to throw

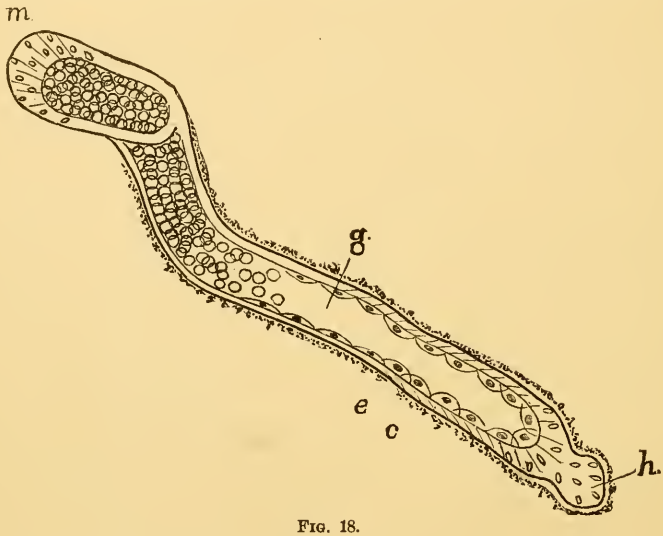

FIG. 18.

out new buds, as shown in Fig. 18 at *m*. For a long time all the buds become feeding hydras; but at last, when the mouths are numerous enough, buds which remain mouthless are formed, and become the blastostyles or jelly-fish producers. The following diagram shows the life-history of Eutima:

VI. EUTIMA.—
Egg = Planula = Root × { Feeding hydra × { Blastostyle × { Medusa < eggs. / Feeding hydra { Medusa < eggs. ; Feeding hydra × { Feeding hydra { Medusa < eggs. / Blastostyle × { Medusa < eggs.

Diagram No. 1, which was given in the beginning of this article, to illustrate the life of Dysmorphosa, shows the next stage in the process of complication, and a comparison will show that it is derivable from Diagram VI by slight changes, just as VI is derivable from V, and this from the preceding, and so on until finally we reach a simple, direct life-history, in which each egg produces one adult, which passes through a transitory larval hydra stage.

Forty years ago, a zoölogist of the old school might have believed that the life-history of Dysmorphosa has always been complex, and that of Liriope always simple; but the doctrine that all the representatives of any great group of animals owe their common characteristics to descent from a common ancestor is one of the fundamental principles of modern elementary zoölogy, and as this doctrine forms the basis rather than the aim of this article, I assume, without discussion, that the remote ancestors of Liriope

and Dysmorphosa were the same, and that all the life-histories which have been described are modifications of that which was exhibited by this ancestor.

The series which has been given shows that this ancestor must have developed directly from the egg, its adult stage must have been the most important part of its life, and the hydra stage only a transitory larval condition. As, in certain lines of descent from

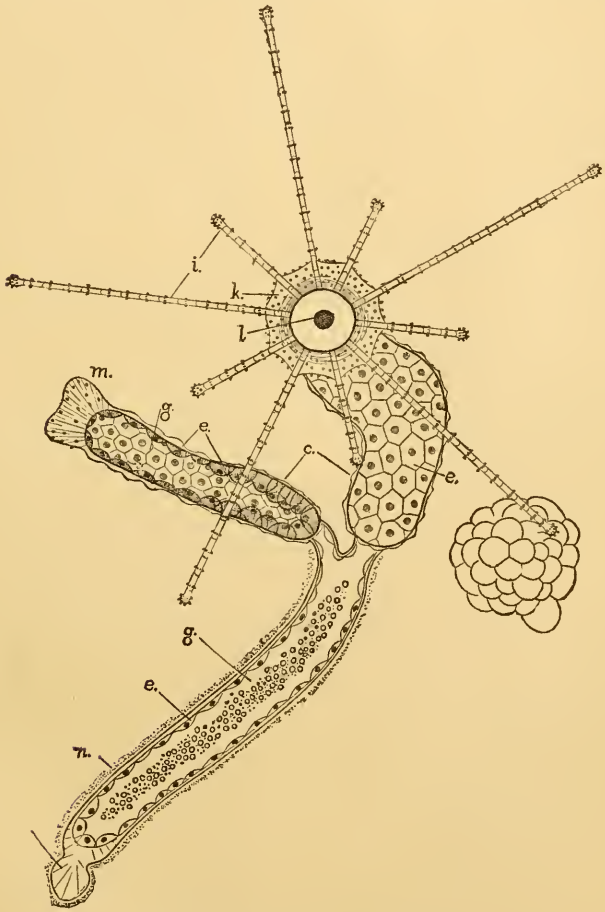

FIG. 19.—Young hydroid colony of Entima.

this ancestor, the conditions of life became more and more favorable for the larvæ, and as successive generations of larvæ became more and more adapted to these conditions, the larval life gradually increased in length and importance, and threw the adult sexual stage more and more into the background, until, in the case of Dysmorphosa, we have a colony of long-lived larvæ, which embody all that is most distinctive and characteristic of the species,

and the adult jelly-fish lives only long enough to effect the wide distribution of the eggs, and the establishment of new colonies of larvæ.

Something very similar to this has occurred in a few insects. The caterpillar stage of most butterflies is simply a preparatory step directed toward an end, the production of the perfect insect; but the bagworm is a butterfly in which the larval life is most important, for, while the caterpillar lives long, the female insect never escapes from her cocoon, but after her final transformation lays her eggs within it and dies, while the male lives only long enough to find and fertilize the female, and then dies also.

In the case of the hydroids, the power of budding, a power which is almost absent in insects, enables the larval life to assume a degree of importance which it could not have if the larva remained simple, for it has rendered division of labor possible, and has produced polymorphic communities, most of the members of which are out of the line of succession. The gradual reduction of the adult life is also facilitated by the process of budding, as this effects a great increase in the number of adults which come from each egg, and thus secures the sexual reproduction of the species, notwithstanding the shortening of the life of each adult.

The shells of hermit-crabs often carry colonies of another hydroid, which is so similar to Dysmorphosa that a drawing of one will answer for the other. They are almost exactly alike, and it is only after careful examination that any difference between them is discovered; but, inconspicuous as the difference is, it is highly important, for in the second form, Hydractinia, the adult locomotor jelly-fish stage has been completely lost, and the whole life of the species has become centered in the larvæ. The blastostyles produce buds, which acquire some rudimentary traces of the organization of jelly-fish, but they never become free or complete their development. While still on the blastostyles, they produce eggs or spermatozoa, and having thus accomplished their purpose and secured the perpetuation of their race, they die. The life of Hydractinia is shown in Diagram VII:

VII. Hydractinia.

Egg = Planula = Root ×	Feeding hydra ×	Feeding hydra	Medusa < eggs.
		Blastostyle ×	Medusa < eggs.
		Defensive hydra	Medusa < eggs.
	Feeding hydra ×	Feeding hydra	Medusa < eggs.
		Blastostyle ×	Medusa < eggs.
		Defensive hydra	Medusa < eggs.
	Feeding hydra ×	Feeding hydra	Medusa < eggs.
		Blastostyle ×	Medusa < eggs.
		Defensive hydra	Medusa < eggs.

This is by no means the end of the story, for the many species of hydroids without any jelly-fish stage present all stages in the gradual simplification of the sessile medusa buds, until at last all traces of the structure of the jelly-fish disappear, and they are

degraded into simple accumulations of reproductive cells—reproductive organs—on the bodies of the hydroids.

No group of animals presents a more complete record of the process of evolution of species than the hydro-medusæ, and the comparative study of the different species gives, with a wealth of detail which is entirely beyond the scope of a short article, all the steps in the progress of modification. The minute gradations are so numerous that a long training is required to grasp them all without confusion, and to read the history which they exhibit, but those which I have selected are sufficient to illustrate the manner in which the larval life has gradually grown into prominence, and has become evolved and specialized, while the adult life has dropped more and more into the background, and has finally disappeared completely.

MAN IN RELATION TO THE LOWER ANIMALS.

By Prof. EDWIN EMERSON.

ON the published bills and circulars of the "Fidelity Trust Company," of Philadelphia, is a representation of a strong-box guarded by a watchful dog. The faithful protection of the dog is a striking emblem of the mission of the Fidelity Trust Company. Fidelity to a trust is certainly a moral quality of a high order. This is such a well-known characteristic of the family of dogs as to have become proverbial. It is a matter of common observation that members of the better class of dogs, such as Newfoundlands and Saint-Bernards, show also other moral qualities: they have a high sense of honor, can not be bribed, will not steal, etc., and are true to the death as to matters committed to their trust. To deny to such animals the possession of moral qualities seems to be absurd. But moral qualities and reasoning faculties are not confined, in the animal world, to dogs alone; far from it. Many tribes of animals have the habit, when necessity seems to require, of posting sentinels to guard from surprise. This practice is in use by the chamois, the deer, the wolf, the goat, the wild horse, the elephant, the beaver, the monkey; the raven, the crow, and many other birds. To consider in advance as to the necessity of placing sentinels, and then to resort to that form of strategic device, is a decided proof of the possession of no small perceptive and reasoning power; and the fact that the sentinels faithfully fulfill the onerous duties of their trust is a striking proof of advanced moral qualities.

Any theory in regard to man's place in nature which denies some degree of reason and moral perception to the lower animals

is so wide of the facts that it must be a mistaken theory. It places man too high, and assigns to the various tribes of lower animals too low a position in the moral and intellectual scale to agree with observation. A wide and unnecessary chasm is thus placed between man and the inferior animals, when, in fact, the lower tribes of men and the higher tribes of animals, such as elephants, foxes, dogs, and monkeys, are not so greatly apart in the line of intelligence and moral perception. Savages recognize this affinity. Thus we are assured that certain tribes of negroes regard monkeys as their near relatives, who have been deprived of the power of speech on account of their mischievousness and badness.

The wonderful manifestations of instinct are so remarkable that the old theory ascribed it to God himself having directly implanted it, "from without and from above"; but that theory has been set aside by modern investigation, and it is now very generally recognized that instinct is the hereditary result of long experience. This being the case, all the manifold exhibitions of reflection and reason, and careful, self-denying affection shown by the various tribes of animals, must be ascribed to the workings of their intellectual and moral faculties through long periods of time.

Dr. Mark Hopkins, in his "Scriptural Idea of Man," teaches that man alone, among the animals upon the earth, is dignified by the possession of what constitutes him "a person." Personality, according to Dr. Hopkins, arises from consciousness, reason, and a moral nature. Consciousness is defined (p. 48) as "the knowledge of his own existence by a being who knows himself to be. . . . Thus arises a knowledge of rights and obligations. . . . Thus man is formed to rule over the lower creation. . . . From all that is below him man is most widely separated" (p. 106). "Of dominion over itself, over nature, or over its fellows, no brute can know anything; nor can it know anything of an intelligent mediation between nature and God. Being destitute of rational and moral elements, the brute can not have the first dawning of either of these ideas" (p. 103).

In reply to these statements we observe—that brutes do rule over themselves, oftentimes exhibiting remarkable self-control. Nothing is more common than for the parent animal to abstain from food until the young ones are provided for. Brutes do rule over each other—scarcely any of the gregarious animals fail to show this power; it is true of monkeys, stags, elephants, bulls, and birds in their migrations. The shepherd's dog rules over the flock committed to his care almost as well as his master As for dominion over nature, the brutes exercise just as much of it as is necessary for their well-being and preservation. A bird that builds its nest in a sheltered place exercises control over nature,

in its degree, quite analogous to the work of a human architect. "The foxes have holes, and the birds of the air have nests." How does the fox get its hole, or the bird its nest? They make them for their purposes, and this is certainly control over nature to that extent. How does the fox support his family if he has no control over nature? Do hens and chickens run into his hole and ask to be eaten? Dr. Hopkins does not seem ever to have heard of the way in which a tribe of monkeys prepare to rob a corn-field. Let us describe it. When they get ready to start on their expedition, an old monkey, the leader of the tribe, with a staff in his hand, so as to stand upright more easily, marches ahead on two legs, thus being more elevated than the others, so as to see signs of danger more readily. The rest follow him on all-fours. The leader advances slowly and cautiously, carefully reconnoitring in all directions, till the party arrives at the corn-field. He then assigns the sentinels to their respective posts. All being now in readiness, the rest of the tribe ravage and eat to their hearts' content. When they retire, each one carries two or three ears of corn along, and from this provision the sentinels are regaled on arrival at their lair. Here we see ability to rule and a willingness to submit to rule; a thoughtful preparation of means to the end in view; and a recognition of the rights of the sentinels to be suitably rewarded at the close of the expedition. Wherein does all this differ from a similar foray of a tribe of savage men? The only difference is in degree; otherwise, it is much the same. Dr. Hopkins's proposition that animals are not possessed of consciousness is mere assertion. He offers no proof whatever. A dog appears to be perfectly conscious of his existence. All his actions are in entire accordance with that view of his activity. Give him a bone, and he seems to be conscious of his rights, too, and is ready to defend them. Observe a dog of one or two years of age, and a child of four or five years, playing together; they understand each other perfectly well, and seem to get equal pleasure out of the sport. Their consciousness of existence is about the same. When the dog gets older, and accompanies his master to hunt, he understands his duties, and performs them about as well as the man performs his share. The dog hunts as truly as the man; takes a lively interest in all the proceedings; is joyous over success, and cast down in case of failure. To deny consciousness to such a being is absurd. It is quite true that the dog has not studied the Cartesian system of philosophy, and can not say to himself, *cogito, ergo sum;* but, neither can the boy who plays with him, nor, probably, the man who hunts with him. A power of analysis and metaphysical introspection is not possessed by young persons; nor, generally, by uncultivated men. They live in the present. They are satisfied with a consciousness of

existence, without prying curiously into its constituents. The power to dwell on the varying phases of the inner life, to analyze them, and to base the outlines of a system of intellectual and moral philosophy upon them, is the result of a high degree of culture and a habit of observing the operations and power of the mind.

It thus seems that what Dr. Hopkins demands as perquisites of personality, viz., consciousness, reason, and a moral sense, are all to be found, in some degree, entering into the constitution of the lower animals. If man is a person, with the accompanying rights growing out of his personality, so is an elephant a person, in his degree, and has his rights accordingly; so is a dog, or a fox, etc., each in his degree. In this manner the immense chasm which Dr. Hopkins has invented as existing between man and the lower animals disappears, and the whole realm of animated nature is restored to unity, as the product of the divine mind. This view, as Dr. Hopkins acknowledges (p. 100), is entirely in accordance with the opinions of the great majority of naturalists now living.

A few words, in conclusion, as to Dr. Hopkins's idea of man being formed for dominion over the whole lower world of sentient being. While we admit that his higher powers give him a certain amount of control over some of the lower and humbler creatures, it is to be borne in mind that innumerable millions of animals lived and roamed over the earth, through many geologic ages, before man appeared on the scene. Were they waiting all this time for their ruler? Man is a very recent animal, and does not go back, probably, further than the Tertiary period at the utmost. But, even since man appeared, his rule over the lower creation has been extremely limited. He has not exercised control over one in a million of the other orders of animals. Beyond a few animals he has been able to domesticate, his rule and kingship have been practically null. Dr. Hopkins feels this difficulty as to his theory when he says (p. 105), "In this sphere his dominion is evidently most limited and imperfect compared with what it would have been if he had not lost dominion over himself." If this is correct, it may be said in reply, that, since man has lost his dominion, it is needless to build up a theory upon the basis of his still retaining it.

Prof. Terrien de Lacouperie believes that he can trace a direct derivation of the oldest characters used by the Chinese from the Chaldean cuneiform writing. This system, which had already become old and corrupted, came from Babylonia through Elam. Tseng-hieh, to whom Chinese tradition ascribes the invention of writing—Dung-kih, or Dunkih, in the oldest form of the name—was probably the celebrated Chaldean king Dungi, known for his numerous inscriptions, who is supposed to have lived about 2500 B. C.

HYPNOTISM: WHAT IT IS AND WHAT IT IS NOT.

By Dr. CHRISTIAN A. HERTER.

IT has so long been the custom of the world, and of scientific men, to look upon Mesmer as a charlatan, and upon mesmerism as a delusion, that it is surprising to many persons to find that men of ability and repute are now engaged in investigating the phenomena which are still known under the vague title of "animal magnetism." The fact is that the teachings of Mesmer contained a certain element of truth, although it was seriously obscured by self-deception and intentional fraud, and that this kernel of truth has already been so far isolated as to show that it is deserving of serious study.

In the pages that follow I propose to give a concise account of the present state of our knowledge about "animal magnetism," or, as it is more properly termed, hypnotism, and shall endeavor to present certain facts in their real light, which have long been misunderstood in consequence of the teachings of Charcot and his pupils. While it can not be said with certainty that there may not exist some kind of "magnetic fluid" as the cause of the phenomena I shall describe, it is certain that a large proportion of them can be much more satisfactorily explained in other ways. Moreover, there is not at present a single well-substantiated fact, so far as I am aware, which requires the supposition of a magnetic fluid, or other similar mysterious influence, as an explanation. There being, therefore, no actual evidence of the existence of any such force as "animal magnetism," the expression may justly be objected to as a misnomer, and we must seek to replace it by a more suitable term. The word "hypnotism," proposed by Braid, of Manchester, is a very good substitute, and has at least the merit of being noncommittal.

It is not easy to define hypnotism sharply. It is probably sufficiently accurate to say that it is a condition of induced sleep almost identical with ordinary sleep, in which the brain is highly and peculiarly receptive of impressions from the outer world. Ordinary sleep is often disturbed by dreams. These dreams, as every one knows, vary greatly in vividness and character. Not infrequently the objects dreamed of are of the most fantastic and unreal nature, but they are nevertheless accepted by the unconscious individual as realities, and indeed have the subjective psychological value of perceptions. The stimuli which give rise to dreams arise as a rule within the brain of the sleeper; they are spontaneous. Let us now suppose that the stimuli come from the outer world, instead of from the brain of the sleeper, and we have

precisely what happens in hypnotism. These stimuli generally consist in words spoken by the hypnotizer to the sleeping subject, who hears and understands everything that is said to him as though it was said in a dream. In many instances the hypnotized person realizes the existence of every object or person called up to his mind by the words of the hypnotizer. He sees the dog, or the man, or the house, exactly as its presence is affirmed by the speaker. He can be made to taste imaginary fluids or hear imaginary voices at the will of the physician, and, as I have just said, all these impressions are as real to him as actual perceptions. His will is so weakened that he can generally be made to execute the most varied motions at the command of the person who has put him to sleep. He may try to resist commands, but the resistance is feeble, and he eventually obeys automatically. His dreams are formed and guided by an external agency, and his muscles are brought into activity and controlled by the same influence.

The ideas, acts, and sensations which can thus be insinuated, so to speak, into the brain of a person in the hypnotic state, through the agency of speech, or any other external influence, are technically called *suggestions*.* Individuals vary greatly in the readiness with which they react to suggestions when hypnotized, and their suggestibility is said to be high or low as the case may be. In general, persons possessed of a lively imagination in the normal waking state, are highly susceptible to suggestion in the hypnotic condition. Thus the two essential elements of hypnotism are sleep and suggestion. The degree of sleep varies in different cases, from the lightest somnolence imaginable, to a condition of profound lethargy, from which the subject can only be awakened with difficulty.

Suggestibility is by no means peculiar to hypnotized persons. Almost every one is sensitive to suggestion to a certain extent when awake, for in every human being, no matter how skeptical he may consider himself, there exists a certain degree of credulity, and this credulity may be played upon and taken advantage of in a measure. Children can be made to believe the most preposterous statements if they are made with sufficient gravity. The majority of healthy children are, moreover, auto-suggestionists; that is, they create air-castles, in which they soon come to believe firmly as objective realities. Too often such auto-suggestions are regarded by parents and friends as deliberate lies. They are in reality simply the creations of phantasy, which have become established as truths in consequence of being unopposed and uncorrected by reason and experience. In the course of time the reasoning facul-

* The French use the word suggestion to express this idea, and although the English suggestion, as commonly employed, does not perfectly correspond with its use as employed by French authors, it answers the purpose better than any other word.

ties are developed and hold the imagination in check. Nevertheless, even adults are met with in whom the imagination so readily gets the upper hand that they may be induced to believe the most impossible things. I recently saw a young woman of moderate intelligence and education who was so readily influenced by suggestion in the waking state that she was unable to move from the place where she stood on being suddenly and decidedly told that it was impossible for her to budge. She could be made to see people who were in reality not present, and on the other hand could be made blind to the presence of persons and objects actually in the room. After repeatedly affirming that she was absolutely insensible to pain, it became possible to pass a needle deeply into the skin without provoking any signs of discomfort.

At first sight, these cases appear like impostures, because they are opposed to common experience, but careful examination shows that there are cases of the kind in which simulation can be pretty effectually excluded. Still, it must be admitted that simulation can readily be overlooked, and that the number of cases in which suggestibility in the waking state is so highly developed must be very small. I am inclined to look upon these higher grades of suggestibility in the waking state as pathological.

These facts have led Prof. Bernheim, of Nancy, to define hypnotism as a peculiar psychical state, characterized by increased suggestibility. In proposing this definition, Bernheim perhaps gives too little importance to the sleep which in the vast majority of cases is essential to the production of a high degree of sensibility to suggestion. At the same time there appears to be no serious reason why the term hypnotism should not be so far extended in meaning as to include those exceptional cases in which the phenomena characteristic of the hypnotic state can be produced without first inducing sleep.

The history of hypnotism is anything but flattering to the penetration and generosity of the various scientific men who during the past century have from time to time passed judgment upon the claims of its advocates, and affords a striking illustration of how the progress of knowledge may be hindered by excessive skepticism.

I can not review even the more important features of the history of "animal magnetism," interesting as it is, except in the briefest manner. The life of Mesmer is full of instruction and romance, and is well worth a careful reading; although one can not help concluding that he misdirected and prostituted his intelligence to his greed of money and love of notoriety, and that he was, upon the whole, a man of very questionable character. As is well known, the central hypothesis of Mesmer's theory is the existence of a subtile universal fluid, which he called "animal magnetism,"

in the belief that its action was in some manner analogous to that of the magnet.

In 1841 Braid, of Manchester, showed that the majority of the phenomena which Mesmer had sought to explain by means of "animal magnetism" could be just as well if not better explained without the hypothesis of a magnetic fluid. He demonstrated, in other words, that we have no reason whatever to believe in the existence of a magnetic fluid as a cause of hypnotic phenomena, and this was certainly a most important step in our progress. Braid showed that it was possible to throw persons into a condition of trance or sleep without the use of any so-called magnetic passes, and without contact of any kind. In order to induce this sleep, he simply required his patient to look fixedly at a brilliant object placed before his eyes, at the same time that he concentrated his thoughts upon the idea of going to sleep. After a variable period, generally two or three minutes, the eyes closed suddenly, the head fell to one side, and the patient was asleep. Braid found that the intensity of this sleep varied considerably in different cases, and that he could sometimes give rise to hallucinations, emotions, paralyses, etc., by simply giving the subject verbal suggestions; that is, by affirming the presence of these various conditions. The various phases of sleep induced by Braid resembled one another so much that he had no doubt they were essentially manifestations of one and the same condition. This condition he called "nervous sleep," or hypnotism.

We may justly say that Braid was the first to study the phenomena of hypnotism in a scientific spirit, and to show that they were in no way miraculous or mysterious. Still, his observations were very incomplete, for he failed to appreciate the nature of suggestion and the subtle *rôle* it plays in the manifestations of hypnotism. In consequence of this, Braid eventually confused hypnotism and phrenology in such a way as to lead him greatly into error concerning the former, and it is probable that, at the end of his life, he was much further from the truth than many years before.

After the appearance of Braid's work, the subject remained *in statu quo* for a number of years. In England, Braid was looked upon with suspicion, and had scarcely any adherents, while in France a number of scientific men became interested in his work, and contributed many observations upon hypnotism.

These observations in general confirmed those of Braid, and it was not until 1866 that Liébault, of Nancy, came to the front with new facts and original views of hypnotism. We can not follow Liébault into his somewhat vague theories of the cause of hypnotism and its various states. It is enough to say that he maintained that the different physical conditions included under

this term are determined chiefly through some form of mental action, and afford striking illustrations of the influence of the mind upon the body. This view of Liébault's is of great significance, for it is the point of departure of the supporters of the Nancy school of hypnotism, who hold that an enormous number of hypnotic manifestations can only be explained through suggestion. Liébault was an extremely conscientious and able observer. He had the courage of his convictions, and, scorned by his colleagues, lived in retirement, practicing among the poorer classes, and devoting his life to the study of the problems of hypnotism. The originality of Liébault's book, and the stimulus it gave to investigation, entitle it to be considered the most important work upon hypnotism which has appeared since the time of Braid.

In sharp contrast to the views held by Liébault and his pupils (Nancy school) stand those of Charcot and his school (school of Salpêtrière or Paris school). Charcot began the study of hypnotism in 1878, and his observations were almost exclusively made upon hysterical patients. His method of inducing sleep is similar to that of Braid. The patient gazes intently upon a brilliant object, and after a variable period falls suddenly asleep. Charcot regards hypnotism as an abnormal nervous state—a neurosis, in fact, of which there are three phases, each possessing certain well-defined characteristics. . The patient may be brought from one of these stages into another at will, by means of certain skillfully performed manœuvres. The three states are known as lethargy, catalepsy, and somnambulism.

The lethargic state may be obtained either by fixation of a brilliant object, or by pressing upon the closed eyelids. The condition is characterized by the presence of deep sleep, muscular relaxation, loss of sensation, partial or complete, abeyance of the intellectual functions, and the absence of all reaction to suggestion. A curious hyperexcitable condition of the nerves and muscles (neuro-muscular hyperexcitability) is, however, present, which causes any muscle to contract when its corresponding nerve is excited by friction or slight pressure. Thus, pressure upon the facial nerve (the great motor nerve of the face) causes distortion of the features on the same side of the face.

The second stage is that of catalepsy. It is only necessary to raise the eyelids in order to transform the lethargic condition into that of catalepsy. If only one eyelid be raised, the corresponding side of the body becomes cataleptic, while the other side continues lethargic. The peculiar hyperexcitability of the nerves and muscles is absent in this stage, and the patient remains for some time in any position into which he may be put. In this stage suggestions may act through the sensibility of the muscles as a medium. Thus, if the hands are joined as in prayer, the face grows very

grave, and the patient may kneel as if to pray. Catalepsy may be converted into lethargy by simply closing the patient's eyelids.

The third stage of Charcot's hypnotic series is somnambulism. Somnambulism can be primarily induced by fixation, or may be developed out of the lethargic or cataleptic stages by light friction on the top of the subject's head. The sensitiveness of the subject to suggestions is very greatly increased. The neuro-muscular hyperexcitability is not present, and contractions can not be produced by excitation of the nerves or muscles. Light breathing upon the skin, however, gives rise to a special form of contraction which, it is said, can only be counteracted by similarly stimulating antagonistic groups of muscles. These three phases Charcot has been pleased to group under the title of the "grand hypnose," for what reason it is difficult to say, unless, indeed, it is because the description originated in Paris.

Thus it happens that, at the present day, the Paris school and the school of Liébault are the principal exponents of hypnotism. Upon many of the most essential questions these two schools stand in opposition. According to Charcot, hypnotism is a pathological condition observed chiefly in hysterical patients, which can be divided into the three sharply defined phases just spoken of. According to Bernheim, who is at present the chief representative of the Nancy school, the hypnotic state is not a neurosis, but a condition closely allied to ordinary sleep, which can be brought about in a very large proportion of perfectly healthy persons. The peculiar physical conditions described by Charcot as invariable concomitants of hypnotism, Bernheim considers the result of suggestion, and the three typical states he regards as the artificial effects of similar influences.

From a careful examination of a large number of hypnotized persons, I am forced to the conclusion that these views of Bernheim's are correct, and that the school of the Salpêtrière is in serious error. Before reviewing the facts which have led me to this conclusion, let us inquire a little more carefully into the nature of the hypnotic phenomena manifested by healthy individuals. This will greatly facilitate an understanding of the principal objections to Charcot's views.

First, as to the proper method of inducing the hypnosis or artificial sleep. This is very simple, and it is always well to assure the subject that you do not intend to make use of any supernatural means, and that there is no magnetism of any kind about your procedure. Where persons are very skeptical of your ability to put them to sleep, it is a good plan to hypnotize a few patients in their presence, as an evidence of what you are able to do. Having thus obtained the subject's confidence, the physician asks him to look him intently in the eye, and to think of nothing

but of going to sleep. The subject should be seated in a comfortable position, preferably with his back to the light. The recumbent position is not usually necessary. While the patient's eyes are still fixed, as just described, upon the operator's eyes, the latter says, in a monotonous but distinct tone: "Your eyelids are getting heavy, very heavy. Your eyes are red and moist. You are getting sleepy, very sleepy, very sleepy. Now you are nearly asleep. Your eyelids are shut; you can not open them, because you are asleep, fast asleep. Try as hard as you will, you can not open them. You can not wake up," etc. While these words are being uttered, the lids begin to drop and the eyes really look sleepy, and, if the subject is a good one, the pupils can generally be seen to dilate and contract alternately.

If two fingers of one hand slightly separated be held before the patient's eyes, he rolls his eyes down, following the fingers as they are moved down until the eyelids actually close. When the eyes close the subject is almost asleep, and a few judicious words affirming that he is asleep complete the hypnotizing.

In order to obtain good results it is necessary to watch the subject very carefully. Every sign of submission to the hypnotic influence should be immediately turned to account. Thus, if the eyes are seen to close suddenly, the subject should be at once told that he is asleep and can not wake up. If, instead, the operator adheres to a rigid formula, he may affirm the presence of sleep too soon, and the subject loses confidence, and the trial fails. *The great secret of success is to watch closely, and suit the words to the symptoms of sleep as they develop.* The importance and the difficulty of doing this well can only be appreciated after trial.

The *rationale* of this mode of hypnotizing is very simple. It consists essentially in an imitation of the processes of ordinary sleep by means of verbal suggestion. The attention is fixed by making the subject look into the physician's eyes, which thus answer the same purpose as Braid's glass knob. The heaviness of the eyelids, the dryness and subsequent moistness of the conjunctiva, and the gradual approach of somnolence, are natural episodes which usher in ordinary sleep. These we actually bring into existence by acting on the imagination through speech. It is a case of verbal suggestion in the waking state. The skill of the hypnotizer consists in making the subject believe he is going to sleep; that is all. It is not necessary that he should possess any peculiarities of temperament and voice, as has been supposed. Strokes and passes are useless, except in so far as they heighten suggestion. In short, everything lies in the subject and not in the hypnotizer. *Nobody can be hypnotized against his will.*

The persons who prove most refractory are so because they either consciously or unconsciously resist the operator's influence.

They are not passive. Persons who are very much preoccupied with a certain idea are difficult to influence; hence hypochondriacal and hysterical patients make poor subjects, largely on account of their introspection and egoism. Many people think that it is a sign of weak will to yield readily to hypnotism, and that it is a sign of strong character to resist. Both views are equally erroneous. I have frequently seen persons of strong, determined character fall asleep at the first trial. On the other hand, hysterical patients with very little will-power are generally highly refractory. Men are as readily hypnotized as women. Imaginative persons, and those who sleep very soundly, are generally easily hypnotized.

It has been repeatedly stated that frequent hypnotization is dangerous. It is questionable whether hypnotism has ever proved really dangerous, even when it is induced as it is at the Salpêtrière. With Braid's method, it often happens that a severe headache or general nervous irritability is produced, and hysterical or epileptic paroxysms are occasionally brought on in persons subject to them. It is important to understand that these evil results are not due to the hypnosis; they are the result of the long fixation. Liébault, Bernheim, and Forel have hypnotized many thousand persons in the manner I have described—that is, by suggestion—and have never witnessed an unpleasant or harmful after-effect.

It is impossible to give an exhaustive description of the hypnotic manifestations here. The most that can be done is to mention briefly the principal classes of phenomena with which one meets; and, having done this, some of the more remarkable ones can be studied by themselves.

Liébault divides hypnotic sleep into six grades. The division is arbitrary and theoretical, and the grades can not be sharply separated from one another, for there are all imaginable transitions. Nevertheless the classification is useful, and I shall give it here as the best means with which I am acquainted of introducing the characteristics of hypnotism.

Under the first degree Liébault includes those cases in which the somnolence is so slight that it is questionable whether it can really be called sleep. There is a sense of drowsiness, often very pronounced, and the eyelids feel heavy, but this influence may only continue while the operator is speaking. As soon as his influence is withdrawn the subject wakens.

In the second degree the subject's eyes are closed. He hears everything that is said to him or that occurs about him, but does not awake spontaneously for some time. As the magnetizers say, he is in the "hypotaxic" or charmed condition.

This degree of hypnotism is characterized by the existence of what is called suggestive catalepsy. If, as soon as the subject is

asleep, one of its arms be lifted, it will remain, in a certain number of cases, just where it is put. It is rigid, and resists any attempt to change its position; that is, it is cataleptic. The phenomenon is called suggestive catalepsy, because it is the result of suggestion and is not spontaneous. The arm is lifted into a certain position; it remains, because the act of putting it there—the suggestion—insinuates into the mind the idea of keeping it there. The psychical process which determines this phenomenon is purely automatic. The will does not come into play.

It often happens that patients whose sleep is no deeper than that just described imagine, upon waking, that they have not been asleep, because they remember what has been said to them; or they think that their somnolence has been due to their desire to be obliging. If they are again hypnotized, the catalepsy can be made to reappear, although the subject may have previously avowed his intention of preventing it.

In the third degree the phenomena just described are present, but the sleep is deeper than before. The sensibility to pain is nearly or quite abolished, and can generally be entirely abolished by verbal suggestion. The physician says authoritatively, "Your hand is dead and can no longer feel anything," and he may then puncture the skin with a needle, and the subject shows no sign of pain. Automatic movements of various kinds can be produced in this stage. The arms may be made to rotate about one another, and the subject may be dared to stop them, but he can not. He hears and remembers everything that is said to him.

All these phenomena are present in the fourth degree, but, in addition, there is loss of relationship with the outer world. The sleep is so deep that the subject only hears what the hypnotizer says. He is in relation with the hypnotizer and no one else, but may be switched off, so to speak, into relationship with any one else at pleasure.

The fifth and sixth degrees are distinguished by forgetfulness of what has happened, or amnesia, upon waking, and constitute somnambulism.* In the fifth degree the amnesia is not complete. The patient still vaguely remembers what has been told him, or may have a confused recollection of what has occurred during a certain period of his sleep, while he may have completely forgotten everything else.

Persons who exhibit this degree of sleep are extremely sensitive to suggestion. They may be made cataleptic and absolutely insensible to pain. They can be made to execute the most varied auto-

* The word somnambulism is commonly used to designate sleep-walking. As used in hypnotism, it has the more extensive meaning of forgetfulness after waking from hypnotic sleep. Very often, however, this amnesia is associated with such highly developed automatic movements that the person is able to walk about.

matic movements, and to experience hallucinations and illusions of the senses. A solution of quinine is drunk with every show of satisfaction if the operator merely states with sufficient emphasis that it is a delicious cup of chocolate.

The fifth degree of hypnotism is known as light somnambulism. In deep somnambulism (sixth degree) the subject has no memory whatever of what has passed during the sleep. There is absolute amnesia. Nevertheless he can hear and obey suggestions with great readiness. There are cases of deep somnambulism, however, in which there is scarcely any suggestibility, and in which all the senses appear to be in temporary abeyance.

The above description of the various grades of hypnotism is far from satisfactory, for every person preserves in some degree his own individual peculiarities and impresses them upon the hypnotic state, and this gives rise to an almost infinite number of varieties which overlap one another in every imaginable way.

The proportion of somnambulists to the total number of persons who can be hypnotized is large, being about nineteen per cent in adults. Sex seems to be an unimportant factor, contrary to what was formerly supposed, for the preponderance in favor of women is only about one per cent. The proportion of somnambulists among children is much higher, being about twenty-six per cent in children from one to seven years of age. More than half the children between the eighth and fourteenth year are somnambulists.

I have heretofore only spoken of the phenomena which are present during the actual sleeping state of the hypnotized subject. In addition to these, there is a class of manifestations which make their appearance after the subject has awakened. These post-hypnotic phenomena, as they are called, are the result of suggestion, and can only be produced in somnambulists. The manifestations themselves only differ from those of somnambulism in that they persist, or only take effect, after the subject awakes. Thus, we can suggest post-hypnotic acts, illusions of the various senses, and hallucinations. For example, a good somnambulist is hypnotized and told that on awaking he will commit a certain act, that he must commit it, and can not offer any resistance to his desire to commit it. Accordingly, when he awakes he executes the suggestion which has been insinuated into his mind, either literally or with some slight modification, and, not having any recollection of what has been told him, believes that his act is spontaneous. These cases afford the best illustration I know of the relativity of our freedom of will, and of the truth of Spinoza's saying, that our consciousness of free-will is but ignorance of the causes of our acts. If the act which has been suggested is one

which might readily be committed spontaneously, the subject makes no comment upon it. If, however, he has been told to do something ridiculous, he is usually a little ashamed of his act, and looks silly and embarrassed; or, if asked why he did such a foolish thing, he invents a justification of some kind, and these excuses are often exceedingly amusing.

It is possible, moreover, to give rise to post-hypnotic illusions and hallucinations of the various senses. Hallucinations of sight are perhaps more readily provoked than any other kind. A person may be made to see a rose, a bright light, a cat, or a devil. In short, in some persons almost every imaginable visual hallucination may be provoked. Binet and Féré have tried to demonstrate the peripheral character of visual hallucinations, by showing that such hallucinations are doubled when the patient looks through a prism. If, for example, a person has an hallucination of a rose, he sees two roses on looking through a prism. Bernheim has shown conclusively that this discovery of Binet and Féré is the result of an imperfection in their manner of experimenting, and that in reality a prism produces no effect whatever on the hallucination. In experimenting on hysterical patients, however, it is very easy to be deceived with reference to this point, for when the prism is placed before their eyes they see at once that everything looked at through it appears double, and conclude, with hysterical shrewdness, that the hallucination ought to be doubled likewise. In other words, they either consciously or unconsciously apply their newly derived knowledge of the effect of a prism to the hallucination.

This assertion is supported by the following facts: If an hallucination be called forth by suggestion in a hysterical patient, in a room which is sufficiently dark to make the objects it contains nearly or quite invisible, the hallucination is not doubled in looking through a prism for the first time, for the subject is unconscious of the fact that the glass through which he is looking has the property of doubling the image of a real object. Repeat the experiment in a light room, and the patient will state that she sees the hallucination double. If the subject of the trial be an unsophisticated child, and not an hysterical woman, the hallucination is in every instance single.

The duration of post-hypnotic hallucinations varies considerably in different cases, but is usually not greater than a few minutes. Instances are, however, recorded where they have lasted hours, and even days. It must be remembered that post-hypnotic hallucinations can only be induced in a moderate proportion of somnambulists.

I can not omit a few words about the state of the circulation and respiration during hypnotic sleep. Braid noticed that, when

a subject was hypnotized, the pulse was at first slowed, but afterward accelerated, and he attributed this acceleration to the occurrence of cataleptic rigidity of the muscles. He also observed that the respiration was increased in frequency, and sometimes became difficult. Later observers have made numerous experiments, some of them very carefully conducted, in order to settle these points, and their results in general support Braid's conclusions. These investigators, however, employed Braid's method of hypnotizing, and this fact vitiates their results, because the continued fixation on the glass knob requires a good deal of physical effort, tires the eyes, and gives rise to a certain amount of emotion, particularly in subjects who have not been previously hypnotized. In consequence, there is a physiological increase in the rapidity of the pulse and respiration, not unlike that which some persons experience when being examined by a physician, and which are therefore to be regarded as the effects of emotion and fatigue, rather than of hypnotism. This view receives confirmation from the fact that subjects who are hypnotized by the suggestion-method of Liébault and Bernheim seldom exhibit any alterations in the rhythm and rapidity of the circulation and respiration. I say seldom, because it does sometimes happen that a nervous person experiences an acceleration of these functions when hypnotized for the first time, even when the suggestion-method is employed.

There are also rare cases of somnambulism in which it is possible to modify the pulse-rate by means of suggestion. Thus, Beaunis reports a case in which the pulse registered ninety-eight beats per minute during the sleep and was reduced to ninety-two per minute by a suggestion of decrease. Then the heart, having recovered from the effects of suggestion, returned to its previous rate of pulsation, and a suggestion of increase resulted in an acceleration to one hundred and nineteen beats per minute.

There are exceptional cases of somnambulism in which it is possible to produce the most astonishing effects upon the circulation of the blood at the surface of the skin by suggestion. Nose-bleeds have actually been produced in this way, and in several cases real blisters were caused. In one of these cases eight post-age-stamps were applied to the shoulder during hypnotic sleep, and the suggestion was given that a blister was being applied. The subject was allowed to sleep all day, and on the following morning the stamps were removed. The skin under the stamps was found to be thick, wrinkled, and yellowish white, over an area of from four to five centimetres in diameter, and around this space there was a zone of intense redness. By four o'clock of the same day, four or five small blisters had appeared, and fifteen days later evidences of inflammation were still present. This case

was observed by Bernheim himself, and there are others of like nature reported by equally competent observers.*

I have tried to show how essential a *rôle* suggestion plays in determining the various phenomena of hypnotism. Let us employ the facts we have gathered as the basis of an examination into the views which have emanated from the Salpêtrière.

As already stated, the experiments of Charcot have been made chiefly upon persons suffering from hysteria, and it is well known that those who suffer from this disease are more prone to every form of deception and simulation than any other known class of beings. Hence we may safely say that it was unfortunate to choose such persons for the subjects of a physiological investigation, particularly as most of the hypnotic phenomena are of a subjective and not of an objective character.

The number of persons in whom the "grand hypnose" already spoken of has been induced at the Salpêtrière is very small, being thirteen in ten years, according to Binet and Féré. These subjects have been regularly hypnotized and experimented upon for a long period of time, and the process has become second nature to them. They have been prepared, and phenomena which they exhibit are in most instances the result of many years of a peculiar kind of culture. They do many remarkable things at the operator's will; but these ought not to be considered as characteristic hypnotic manifestations. It is much more correct to look upon them as hypnotic tricks, if I may use the expression. A patient is hypnotized and goes into the so-called state of lethargy. A bright light is held before the eyes, the eyes are opened by the operator, and the patient is cataleptic; but no one can pretend to say that the catalepsy thus induced is characteristic of hypnotism. The subject has become cataleptic through a sensorial suggestion —the bright light—simply because she has learned to do it, probably by seeing other patients similarly affected or by hearing the operator speak of the effects he expects to get. Take a healthy person and hypnotize him. When he is sound asleep, open his eyes with a bright light before them and observe whether he becomes cataleptic or not. Either he simply wakes up, or his lids close again and he relapses into sleep. It is possible that in very rare instances spontaneous catalepsy may make its appearance, but it is always difficult to surely exclude the influence of suggestion by word, gesture, or imitation. Even in hysterical patients the cataleptic state may be dissolved or prevented by the use of suggestion.

MM. Binet and Féré, Prof. Charcot's assistants, imagine that

* Although I have never seen the effects of suggestion carried to this point, I have several times seen distinct localized erythema created through repeated and energetic suggestion.

they have eliminated the effects of suggestion because they make their experiments in their so-called cataleptic and lethargic stages. They say, "These (stages) are unconscious stages of the 'grand hypnose,' stages in which the condition of the senses and intelligence renders the subject a perfect stranger to what is going on around him." Nothing could better illustrate the imperfection of their method of research, for, as we have seen, some knowledge of what is going on is retained in all but the most exceptional cases.

The number of non-hysterical persons hypnotized by Liébault, Bernheim, and Forel is very great. Yet not one of these observers has ever been able to obtain the results of the Paris school except through the use of suggestion.

The use of a bright light or the simple opening of the lids to produce catalepsy, and the friction of the head to produce somnambulism, have been found absolutely unnecessary by these observers, no matter whether the patient has been hypnotized by Braid's method or by the suggestive method. As we have already seen, all that is necessary to produce catalepsy is to lift the arm or affirm the existence of rigidity. If the sleep be profound enough, the automatic movements which usually occur in somnambulism can be provoked by simple suggestion, *and, if the sleep be not sufficiently deep, no amount of friction of the head unaided by suggestion will produce somnambulism.*

We may safely conclude, therefore, that in reality the "grades of the hypnotic series" do not exist as such. There is no sharp line of demarkation between the so-called lethargic, cataleptic, and somnambulistic stages. *The existence of catalepsy and somnambulism is dependent entirely upon the degree of sleep and the nature of the suggestion.* I do not mean to say that the Charcot school have described what they have not seen, but it seems probable that they have misinterpreted what they have observed, and have not taken into account the influence of suggestion in producing the conditions which they hold to be spontaneous. That they have succeeded by repeated hypnotization and either intentional or unintentional suggestion in reproducing a condition in their subject close akin to a neurosis I am fully convinced; but I hold that a state obtained in this way should not be taken as a basis for a description of hypnotism.

If the thirteen cases of the "grand hypnose" at the Salpêtrière were the only examples known of the effects of hypnotism, there might be some justification for looking upon them as typical examples; but to do this in the face of many thousand cases of hypnotism induced in non-hysterical persons and presenting uniform characteristics of a widely different nature, seems to be a one-sided position to say the least. I have no desire to detract from

the just reputation of one who has done so much to advance the science of medicine, but I believe that in reference to the subject of hypnotism Charcot has committed a serious error in regarding a neurosis which is unquestionably an artificial derivative of hypnotism as the type of hypnotism itself, and it seems probable that this error is largely due to a failure to appreciate the subtle *rôle* of suggestion.*

We have now reviewed the more important facts at present known about hypnotism. Into the question of cerebral physiology I can not enter here, for I desire to confine myself to facts, and we can not go far into that realm unless we give ourselves up to speculation and abandon the surer footing of facts entirely; nor can I stop to speak of the interesting phenomena of spontaneous double consciousness, of retroactive hallucinations, and of spontaneous somnambulism. Full descriptions of these and of many other interesting conditions can be found in the more recent treatises upon hypnotism.

The medico-legal aspects of hypnotism have recently been very carefully studied, and only a short time since a special treatise appeared upon the subject. The forensic questions suggested by hypnotism are certainly of great interest, but I can not help thinking that their actual importance has been considerably exaggerated. The problem is such a novel one and suggests so many curious possibilities that it is not strange that some persons should have had their mental equilibrium a little disturbed from speculating about it.

In conclusion I wish to make a few remarks about the value of hypnotism in the cure of disease. This is a subject upon which the greatest difference of opinion at present exists among professional men, but there can be no question that the majority maintain an attitude of the most rigid skepticism. That it is very difficult at present to form an exact estimate of the therapeutic value of hypnotism is certain, but I can not help believing, after careful observation of a considerable number of cases in which it was tried, that the virtues of hypnotic suggestion are real and great. To be sure, the class of maladies in which benefit can be expected is limited. There is no evidence at present that organic states of disease can be in any way modified by hypnotism, and it is not probable that there ever will be. But there is evidence, and evidence of the best kind, that a large number of functional diseases have been benefited and even permanently cured. Liébault, Bernheim, and Forel have succeeded in curing, or at least in improving, such conditions as headache, functional disturbances of the bladder, St. Vitus's dance, writer's cramp, migraine, neuralgia,

* I recently had an opportunity of studying the cases of the "grand hypnose" at the Salpêtrière, and my belief in the correctness of Bernheim's views was fully confirmed.

sleeplessness, constipation, diarrhœa, and certain manifestations of hysteria. Still, I do not wish to imply that hypnotic suggestion is of use in all forms of functional disease. In a large number of trials of the influence of hypnotism upon the insane, Forel found that the insanities supposed to be unaccompanied by anatomical changes in the brain were as little benefited as those which are known to be the result of actual brain-disease.

The majority of the insane are difficult or impossible to hypnotize. Yet, with insistance, it is possible to influence a small proportion of cases, and to even temporarily abolish hallucinations; but in general the results are unsatisfactory. In a series of experiments made to determine the effect of suggestion upon the fixed delusions of the form of insanity popularly known as monomania, it was found that the delusions could occasionally be driven away for an instant during sleep—that is, the patient could be made to renounce them; but in every instance they were present to their fullest extent as soon as the hypnotic influence wore off.

Chronic alcoholism is one of the conditions in which the most gratifying effects have been obtained by therapeutic suggestion. In several instances the habit of drinking was permanently broken, and all desire for alcohol destroyed by means of energetic suggestions against its use. The habitual use of morphine, chloral, and cocaine has been similarly overcome. The constant surveillance of such patients, afforded by an asylum, is of course an important auxiliary feature in determining such cures. One must not speak with too great certainty as to the permanency of these cures, for the cases have not been under observation long enough to preclude the possibility of relapse.

In a few cases, certain bad habits in children have been broken through suggestion, and I am confident that hypnotism has an important application here.

The frequency and duration of the hypnotic sittings, as employed for the cure of disease, vary with the character of the ailments. In chronic alcoholic disease, for example, the patient should be hypnotized every day for at least half an hour, and it is generally many weeks before much benefit can be obtained. On the other hand, attacks of neuralgia or migraine may sometimes be cured at a single sitting. I recently saw a case of spontaneous somnambulism in a young girl cured in this way. The patient was in the habit of walking in her sleep, and had been under treatment by physicians for a long time, but none of them had succeeded in doing anything to improve her condition. Finally, she was brought to Prof. Forel, was hypnotized and treated with energetic suggestion, directed against her sleep-walking. Six months have elapsed, and the somnambulism has not once reappeared.

The exact indications for the use of hypnotism have not yet been determined, but it seems probable that functional nervous disorders will be one of the classes of cases in which it will always be most successfully used.

In order to get the best results in any individual case it is important to make all the suggestions in the somnambulistic state, in which there is amnesia upon waking. Otherwise it is impossible to obtain such complete control over the patient's mind.

Such, then, are the uses of hypnotism as we at present know them. Unfortunately, there are abuses also. I have said that, when properly employed, hypnotism is absolutely harmless. When, however, a nervous or hysterical woman is repeatedly hypnotized for half an hour at a time, for the purpose of exhibiting her powers to an inquisitive public, the case is different, and I believe that the patient is harmed physically, mentally, and morally. Unfortunately, traveling "magnetiseurs" are not the only persons who give such exhibitions. I was recently present at a public demonstration of hypnotism in Paris, given by a well-known French physician under the name of a scientific lecture, which was nothing more than a vulgar unscientific catering to the curiosity of an equally vulgar and unscientific public. If a law similar to that of Belgium, prohibiting such abuses of hypnotism, were immediately carried into effect in other civilized countries, I believe there would be a timely prevention of much mischief. As it is, the matter will probably be overlooked until enough harm has been done to convince thoughtful persons that some decided measure is necessary to prevent injury at the hands of ignorant or unprincipled persons.

ETHICS AND ECONOMICS.

By ROBERT MATHEWS.

WHATEVER else the theory of evolution has done for human thought, it has at least added two phrases to our current literature that, by the frequency of their use, have done much to mold opinion into harmony with the ideas that are supposed to underlie them. Open any magazine or journal of the day, and one is almost sure to find on some of its pages "the struggle for existence" and "the survival of the fittest." The wide acceptance of the Darwinian hypothesis, of which these phrases are the embodiment, has naturally caused them to be applied to the predominant form of social conflict—industrial competition. In thus applying them, we have also brought with them ideas derived from the study of the way in which the struggle for existence has gone on in the past. The survival of

the fittest seems to have always been the survival of the strongest, keenest, swiftest, or the shrewdest, sharpest, most cunning and crafty. Nature, in selecting, seems to have no pity for the weak. She crowds remorselessly to the wall all who are not capable of sustaining themselves.

The analogies between physical life and social life are so striking, that it is perhaps not wonderful that political economists have applied this law of selection to the struggles caused by industrial competition. And when teachers and thinkers have so applied it, it is still less strange that, in the actual conflicts of industrial life, many men have adopted it as a rule of conduct. Indeed, if it be maintained that the science of political economy rests upon self-interest, and that its predominant force is competition, it would seem to be only a logical deduction that the struggles of trade must go on in a similar manner, and with similar results, to those that have occurred among animals. Even if it be urged that enlightened self-interest teaches that in the long run the welfare of the individual and the welfare of his fellow-men coincide, yet it may be replied that this coincidence is not complete and universal; and that, when self-interest is subjected to the stress of competition, it is very apt to result in pure egoism. Shall we, then, conclude that the rivalries of business, being but another form of the struggle for existence, must be carried on in the same spirit, generating like qualities, and for similar ends, as those which have accompanied the development of physical life; that material progress can only be assured by the big fish eating the little fish? This is not a comforting conclusion to reach, but the important question for us is, is it true?

Accepting the law of the struggle for existence as applying to life in all its phases from low to high, we have first to note an important difference between physical and social life. The laws governing the first are inexorable; that is to say, the organism affected can do nothing to determine the result. But in the social life of men their volitions are part of the necessary conditions. Herein lies an important difference between the methods of the simpler and the more complex sciences. For, "as Comte acutely pointed out, in the simpler sciences our object is gained if we can foretell the course of phenomena so as to be able to regulate our actions by it; while in the more complex sciences our object is gained when we have generalized the conditions under which phenomena occur, so as to be able to make our volitions count for something in modifying them." * In the physical sciences the method of study is to *eliminate one by one the conflicting conditions,* until the necessary condition is reached and the true cause discovered. In the social sciences the method consists

* Fiske's "Outlines of Cosmic Philosophy," vol. ii, p. 170.

in *generalizing all the conditions* until a more complete knowledge of them enables us to make our volitions count as a factor in determining the result. In other words, simplifying the problem in the latter case does not lead to true conceptions, as in the former, for the reason that in the social organism the interdependence of all the parts makes it essential that we study them in combination, as by the elimination of any that are important we get another organism, and not the one we are studying.

In the physical sciences, also, exact prevision is possible, because the forces considered are permanent and reliable, and never self-directing or animated by a conscious purpose. But, in the social sciences, some of the forces concerned are, within limits, self-directing and self-conditioned. Hence, exact prevision becomes impossible; but what we lose in this way is in part counterbalanced by our own ability to modify phenomena through volition and by an exact knowledge of other conditions, so as to bring about a desired result.

We have next to note a difference in the meaning we should ascribe to the "survival of the fittest" when we use the phrase in connection with social growth. It is apparent that what we should now have in mind is the survival of the socially fit. Adaptation of organism to environment means harmony with the conditions of life which surround it, and social growth is made possible only by the development of those qualities of mind and body which are both a cause and a consequence of living in society. It is obvious that such traits of character as are the outcome of a fierce struggle for individual existence would necessarily hinder, if not entirely prevent, social development, and that the fact that society is the prevailing form of human organization indicates that along with the fierceness, the intelligence, and the skill which past struggles have produced in man, there have also grown up certain moral traits which must have been even more powerful in determining the character of the social organism, than their opposites.

For the purpose in hand, we desire to call attention to the necessity of basing our political economy on moral rather than on selfish instincts. Powerful though the latter be, they are more or less anti-social in their nature, and therefore would not, of themselves, favor economic growth. That depends for its development on social growth, and it is only when the selfish instincts are held in due check and subordination to the higher impulses that the latter is possible. Strength, keenness, and shrewdness are important factors in determining the survival of the individual, and, in so far as they do this, they favor also the survival of the race. But of more importance still are those traits which, by enabling men to live together in peace, render possible the

organization of labor in such a manner as to secure the greatest economic return. In a word, our political economy, which has been unmoral, must be made moral, if it is to be the science which shall direct men into the proper paths for the production and distribution of wealth.

In determining the character of ethical economics, it is necessary that we should have some principle to guide us in directing its course. This has already been hinted at in the suggestion that it is by the survival of the socially fit that economic growth is furthered. Now, society is an organism made up of mutually dependent parts, and for its existence a certain social order is necessary, and all actions which militate against that order are more or less immoral, according to the degree in which they detrimentally affect it. Conduct which tends to lower social vitality we hold to be bad, that which tends to raise it we consider good; and every practical attempt at reform proceeds upon this basis. Such changes involve alterations in the social constitution, and the production of an organism whose relations to the conditions of its life will differ from that which preceded it, and our test of the morality of the change will be its utility, "in the sense in which utility means fitness for the conditions of life." Hence, our test of ethical economics is social well-being. Let us subject the working of the strongest economic force to this test.

Industrial competition does not engender a struggle for existence, but rather a struggle for subsistence, and generally a struggle for a subsistence of a particular kind. Where the standard of living is high and the wages of the workingmen correspond to it, it is obvious that, other things being equal, the laborer who is well fed and well clothed will produce more than if under-fed and scantily clothed. The human body, like the steam-engine, depends upon heat for its motive force, and food is its fuel. A certain amount of food is absolutely essential to life. A small increase renders man capable of doing a little work. If, now, we add twenty-five per cent more heat, we get much more than a quarter more work. We probably double the economic energies of man. Let us double his supply of food, give him "a liberal, generous diet, ample to supply all the waste of the tissues, and to keep the fires of the body burning briskly, generating force enough to allow the laborer to put forth great muscular exertions through long periods of time,"* and we reach a high degree of economic efficiency.

There is, of course, a limit to this increase of food beyond which power is not increased proportionately, and, indeed, too great an increase may do harm rather than good; but it is a general rule that raising the standard of living in one direction

* "Political Economy," Walker, p. 49.

tends to raise it in others, and eventually in all directions, and while this may not increase the individual's power of production directly, it may do so indirectly, by raising the scale of intelligence, and creating new desires, particularly for those immaterial products which it is the peculiarity of a high civilization to furnish in increased proportion as compared with the elementary and material utilities. We do not always class these as wealth, but they are, nevertheless, some of its highest forms, and are important factors in advancing civilization.

But let us now suppose that the standard of living is lowered, through a succession of bad harvests and bad years, or through the importation, in numbers large enough to seriously affect the labor market, of laborers from outside, with a much lower standard of living, and who can work for much lower wages, or from both causes combined, or from many others, such as bad laws, lack of sympathy for our fellow-men, etc., and what will be the result?

In the struggle for existence, the weaker go to the wall, and are killed and removed from further participation in the conflict. The fittest only survive, and the result of the conflict is to leave them more capable of taking care of themselves. But this is not a necessary outcome of the struggle for subsistence, unless it should be carried on long enough to become a veritable struggle for existence, which rarely occurs. On the contrary, men are not killed and thus got rid of as further competitors. They are made miserable, less fit to work, and incapable of that mobility which, if present, enables the social organism to so distribute the blows that fall upon it as to cause it the least trouble, and to render recuperation easier. "When the mobility of labor becomes in a high degree impaired, the reparative and restorative forces do not act at all." On the contrary, "industrial injuries, once suffered, tend to remain." * The constitution of society becomes impaired. The standard of living for large masses of the people is lowered, but competition is not thereby destroyed; it is more frequently intensified. Unlike the struggle for existence among animals, the economically and socially fit do not kill off the unfit, and so have the field to themselves.

Do not understand me as condemning competition altogether. Its advantages are many and great. Material progress would have been impossible without it, and under certain conditions it works out a moral result which it would be difficult to bring about by any other social force. But, tried by the test of social well-being, competition is shown to have certain inherent limitations which we must ever keep in mind. It is only by studying economics in close relation to ethics that we can do this, and it is

* "Political Economy," Walker, p. 275.

our purpose now to search for the ethical laws or principles that should govern economic practice.

If there is any one thing that both theory and practice have shown to be of economic advantage to man, it is the existence of private property. So essential is property to social welfare that, as some one has said, "if it did not exist, it would be necessary to invent it." If effort were not rewarded with results, if men were deprived of the fruits of their labor, they would soon cease to work. No thriving society exists without personal property, and, no matter how selfish were the motives that induced its accumulation, the possessor can not amass or dispose of it without conferring some benefit on his fellow-men. Where property rights are not secure, you find lack of energy, rapacious usury, and deep misery. Where these rights are recognized and protected, you have industrial activity in every direction. Men become alert, vigilant, and independent; watchful of their rights, and jealous of their freedom. In their desire to gratify their own wants, which the right of personal property secures to them, they study to supply the wants and desires of others. Thus it becomes the strongest stimulus to production, and the mass and variety of material goods now existing may be said to be the result of this stimulus. Surely no one will question its beneficence.

The earlier economists assumed that the right to private property was a natural right, or primary truth, which needed neither explanation nor defense. This was the general opinion, and, to a great extent, it is still the prevalent opinion. But the great increase in wealth that has occurred, and the lodgment of large masses of it in the hands of a few, coupled with the existence of vast numbers of poor who with difficulty manage to secure just enough to live upon, have brought up the question of the distribution of wealth. As a result, objection has been taken both to the right of private property and to the fact itself. This objection has not been confined to theorists, but large bodies of men, through various schemes of communism or socialism, are endeavoring to either get rid of private property altogether, by making it all common property, or through limiting the right of holding it, by making the state the only possessor of many of its forms.

Ability has not been lacking in the proclamation of these objections, and they have been of all degrees, from Proudhon's celebrated *mot* that "all property is theft," to George's eloquent plea that the cause of poverty is private ownership of land; but *mots* are not proofs and eloquence is not always truth. Yet there must be some other explanation for this phenomenon than is to be found in the envy and jealousy of some over the good fortune of others.

The sentiments and feelings of those who find fault with the existing economic order are in part accounted for by their disap-

pointment with the results which the invention of labor-saving machinery promised to fulfill. "It was expected that labor-saving inventions would lighten the toil and improve the condition of the laborer; that the enormous increase in the power of producing wealth would make real poverty a thing of the past."* For the first time in the history of the world the niggardliness of Nature seemed to have been overcome, and it appeared possible for man to produce enough to satisfy all his wants. The cry of "overproduction," now so generally heard, lends some color to this view. Yet it is susceptible of mathematical proof that if the whole production of the civilized world could be distributed equally among all the inhabitants thereof, it would not raise any of them to affluence or rid them of the necessity of close economy and of hard, continuous labor. This disappointment with Nature does not, however, wholly account for existing sentiment in regard to the distribution of wealth. There is still a residuum to be explained.

The fundamental principle upon which social intercourse rests is that of equal freedom, or the right of "every man to do all that he wills, provided he infringes not the equal freedom of any other man." † Certain conditions are necessary to social well-being, and this equality of freedom is essential, so that men's characters may be wrought into harmony with these necessary conditions. It is upon this right to equal freedom that the right to property rests: indeed, the two rights are regarded as synonymous. "The legitimacy of private property has, since the time of Locke, been based by the greater number of political economists on the right inherent in every workman either to consume or to save the product of his labor," ‡ that is to say, on the freedom to do as he wills with his own, provided he does not infringe upon the equal right of others to do the same. Furthermore, it is a logical deduction from the principle of freedom that every man is entitled to claim as his own the fruits of his labor and his savings, for this principle requires not that all shall share alike, but that each shall have like freedom to pursue and acquire the object of his desires.

Beyond the restraints which the law of equal freedom itself imposes, there are other secondary restraints which are necessary to right living. Men may in a variety of ways make themselves obnoxious to their fellows without breaking the law of equal freedom; hence the necessity of both negative and positive beneficence as supplementary principles to regulate human nature. These, however, belong to the sphere of ethics proper, and not to that part of it we are considering.

It seems to be an inevitable conclusion that, subject only to

* "Progress and Poverty," Henry George, p. 3.

† "Social Statics," Herbert Spencer, p. 121.

‡ Roscher's "Political Economy," vol. i, p. 235.

the limitations just mentioned, we are entitled to do what we please with our own, and this also seems to be in accord with the principles of justice, of which, indeed, the law of equal freedom is the embodiment. But does this cover the whole extent of our obligation? Every right has for its correlative a duty to be performed. Are all such duties included in the limitations upon rights that have been mentioned? Has society no just claims upon its members other than those of mutual forbearance? Clearly not, for rights are not the measure of duties. The latter occupy a much larger field of life, and, although their consideration is chiefly confined to ethics proper, yet in the study of economics a clearer recognition of social duties and an insistance upon their needfulness as factors in securing the greatest economic return for efforts expended will tend to put the science upon a surer foundation. Take, for instance, the great question of *laissez-faire*. As Prof. Sidgwick says: "We can not determine what government ought to do without considering what private persons may be expected to do; and what they may be expected to do will, to some extent at least, depend on what it is thought to be their duty to do; and, more generally, it was before observed that in the performance even of the ordinary industrial functions with which economic science is primarily concerned, men are not merely influenced by the motive of self-interest, as economists have sometimes assumed, but also extensively by moral considerations." *

We have here reached also an explanation of the residuum of existing sentiment in regard to the distribution of wealth. The duties which its creation imposes upon all the men who produce it are not distinctly realized by the mass of mankind. On the contrary, individuals and classes are more often concerned with their own rights and the duties of others. Dissatisfaction naturally follows, as we are sure to find fault with others for the non-performance of duty, while forgetting that our own neglect must produce the same dissatisfaction elsewhere. This applies as well to the laborer as the employer or capitalist. All owe it to society that they shall exercise their economic functions in such a manner as to enhance the social well-being. For, "it should not be forgotten here that, at least in the higher stages of the economy of nations, scarcely any work or saving is possible without the co-operation of society. And society must be conceived not only as the sum total of the now living individuals that compose it, but in its entire past, present, and future, and also as being led and borne onward by eternal ideas and wants." †

This is not the only economic service which society renders to

* "Principles of Political Economy," p. 583.

† Roscher's "Political Economy," vol. i, pp. 235, 236.

mankind. In addition to the security which it gives to labor and to property, it increases their value as well. "Social growth creates a demand for a constantly increasing quantity of every sort of staple goods. The greater the quantity demanded and sold, the less is the cost of production per unit of product. Not that the mere multiplication of human beings is itself creative of wealth, but that the multiplication of utilities by the productive labor of additional human beings enhances the utility created by each one. It does this by creating the means for more perfectly utilizing all labor and all means of production." *

Let us now apply the principle of social duty and the test of social well-being to some of the economic questions of the day. Does our social duty, or the social welfare, require of us that we shall surrender the right of private property, either in whole or in part, as demanded by the communist and socialist? We have already indicated some of the advantages which result to society from the individualistic idea of property. It now remains to point out the disadvantages which would be likely to follow from the adoption of the communistic or socialistic ideal. The first proposes to organize society "so as to distribute the annual produce of the labor and capital of the community either in equal shares or in shares varying not according to the deserts but according to the needs of the recipient." †

The decisive objection to this theory is, that it violates the first principles of justice, in that it proposes to distribute rewards, not in accordance with efforts expended, but in accordance to need, no matter how that need was occasioned, whether through the fault or the misfortune of the recipient. The unequal results that are caused by equal freedom may be deplored and voluntarily alleviated; but it would neither be wise nor well forcibly to prevent these results by taking away from the more fortunate, and thus preventing the natural penalty to be visited upon the slothful and the idle. The inevitable result of such a policy would be to decrease the amount to be divided by removing the normal stimulus to industrial activity, and preventing the normal check upon laziness.

So far as socialism involves a similar theory, the same objections may be urged against it, but this word is generally used to cover the proposition of substituting the governmental for private and competitive management. Now, it is the testimony of nearly every competent observer that governmental management is less economical, less energetic, and less plastic than private management. The result of its substitution would be in the long run to lower the product both in quality and quantity, through

* Franklin H. Giddings, in the "Quarterly Journal of Economics," April, 1887, p. 371.

† Sidgwick, "Political Economy," p. 526.

waste, incompetence, and a tendency to retain old methods where new and better ones should be tried. The reasons for this are not far to seek. Lacking the normal and powerful stimulus of self-interest, as well as the energy which is the outgrowth of competition, the state, as an industrial agent, can never be relied upon to equal in productive results the present system of individual management. But this of itself would not necessarily condemn it, if it can be shown that socialism, by raising the moral tone of society and more equitably distributing its economic product, gets rid of those evils which, it is claimed, are caused by individualism, and, thus elevating the standard of social well-being, more than balances the loss in production. It is indeed conceivable that men might live happier and better than they do at present by restoring the ancient ideal, and limiting their wants to those things only which are essential to human welfare; and that production might, as a whole, be less than it now is, and yet society be better off, if work were so guided that there should be no such thing as overproduction of some articles and underproduction of others; or that such a ratio should be preserved that the purchasing power of the masses would keep pace with their productive power.

To this, however, it may be replied that there is no good reason for thinking that the state will be a better judge of what is essential for human welfare than the individuals who compose it, and it would not be as sure a check upon "overproduction" as the self-interest of the individual producers; for this will keep them alert and watchful of the conditions affecting demand and supply.

Moreover, the interests of society are advanced in several ways by the unequal distribution of wealth. If all existing wealth were equally distributed, it would not raise any one to affluence, or make unnecessary hard and continuous labor. A certain amount of leisure is absolutely necessary to the cultivation of those tastes and talents upon which the general culture and special knowledge of mankind depend. It is obvious that, where men have no time to devote to such matters, in consequence of the necessity of giving all their hours of labor to the production of the essential means of existence, the higher and particularly those immaterial forms of wealth out of which many of the greatest social gratifications are obtained will either not be produced at all, or produced to only a limited extent. Hence, the general culture of the community will suffer from this lack, and a lower type of organism will be developed.

To a certain extent the cultivation of science might, in such a community, be made a means of bread-winning, as its usefulness could be made more apparent, but the pursuit of knowledge would

be likely to be confined to practical ends, and the resulting disadvantages to society would be very great. It would be impossible to calculate the amount of social benefit that has accrued from the unremunerated intellectual activity of men who have devoted their lives to the pursuit of knowledge for its own sake. Much of this devotion has been made possible by the existence of rich men who have directly or indirectly furnished the means to this end. Many of our schools, colleges, libraries, and art-galleries have been founded or more or less supported by contributions from the rich, and a deeper and richer economic return has been made possible.

But the fundamental objection to socialism is, that the economical disadvantages which its adoption would surely entail would not be balanced by ethical benefits that would repay the loss. The evils of which socialists chiefly complain are due to the inherent defects of human nature as it is. While some of these defects may be increased and intensified by the system of private property and free competition that now obtains, it is altogether unlikely that a change in the system would of itself greatly modify human nature. That requires long time and a co-operation of all the social factors. Moreover, the growth of the sense of social obligation gives promise that these very defects may be lessened and eventually overcome, by a more thorough recognition of our social duties and responsibilities, and the cultivation of a public opinion that will insist upon their performance. The main "justification of the existing industrial system is that it secures more responsible and far-sighted management of capital than could be obtained in any other way"; but when we "attempt to enjoy the rights of property without corresponding responsibilities," we give our opponents their most powerful weapon.*

As a first requisite to the establishment of a correct public opinion, it is needful that we should teach more broadly the truth that men have no absolute right to do as they please with their own, and that the obligations which contract imposes are not the only ones to be taken into consideration. Not only must we, in accordance with the law of equal freedom, forbear to interfere with the equal rights of others, but we must also remember that our duty calls upon us to use our rights in such a way as not to demoralize, but on the contrary to conserve, the community in which we live. The test of this is the principle with which we set out—the well-being of society. We may not always be able to decide positively as to what is best in every case for the social welfare, but it is possible for us to do so in many instances; and wherever the absolute exercise of any right, which the principles of political economy otherwise sanction, seems likely to be detri-

* "The Nation" for December 1, 1887, p. 431.

mental to society, it is our duty to point out the limitations of this right, and to do so with the greater insistence, because the natural propensities of man will generally lead him to choose immediate rather than remote advantages, although the latter always coincide with the well-being of society. In other words, morality becomes the basis of our economics; for it is the "cardinal trait of the self-restraint called moral" that it is made up of those representative and re-representative feelings which, becoming increasingly ideal, enable us to postpone immediate for future gratification.*

The basis of the old political economy was self-interest; its fundamental assumption, that "men strive to obtain the maximum of satisfaction with the minimum of sacrifice"; and the creature that it studied was the "economic man." There was much of truth in all this, but not the whole truth. Our ethical economics adds to self-interest the social interest, and the being whom it studies, "the starting-point as well as the object-point of our science, is man" † as he is, with all those thoughts and feelings, those longings, desires, and wants, both of the body and the mind, which are a product of the social factor.

The history of our economic thought and economic action is a further proof of this. There seems always to have been a tendency to the establishment of a moving equilibrium between those forces which make for individualism and those forces which make for socialism, and an extreme development in one direction brings more strongly into play the opposite tendency. Individualism has just had its day; socialism seems now to be coming to the front, but, if not curbed before it has gone too far, the pendulum will again swing toward unappeasable individualism. Happily, however, for man, he is more susceptible of change in the direction of his nobler impulses and toward an ever-growing sense of justice and duty; and, wherever sympathy does not conspire to produce this result, it is eventually brought about by self-interest. Whenever the public opinion of any community allows men to "enforce their rights with hands of iron, while they disclaim their duties with fronts of brass," a reaction is sure to occur sooner or later, and, in order to preserve and retain some of the rights which this reaction imperils, greater concessions must be made to the opposing sentiment. These concessions, once obtained, become the starting-point for new rights and duties, and when these are found to be useful to society they are preserved. A new adjustment is inaugurated, but this time upon a higher moral plane than the former. Thus, "at the suggestion of some immediate interest or convenience," or through the impulse of the higher moral feelings

* See Spencer's "Data of Ethics," chap. vii.

† Roscher's "Political Economy," vol. i, p. 51.

which have already been brought about as described, "fresh types of conduct gradually set into form and give rise to corresponding rules. These rules are the body of morals." * Nor is this all. As this conduct becomes habitual in the individual it affects him physiologically as well as psychologically, and through the changed cerebral structure which it produces, it is transmitted to his offspring, to become in the long process of the ages those moral intuitions which we group under the name of conscience. Note further that the kinds of conduct which our intuitions regard as authoritatively prescribed are such as long social contact has shown to be essential to the well-being of society, and that this same well-being furnishes us the test of our duty to fulfill obligations which for any reason have become ambiguous and indefinite. May we not conclude, then, that the fulfillment of duty to self and to society is the true end of economic action? If so, "let us bind love with duty, for duty is the love of law, and law is the nature of the Eternal" †

CURIOSITIES OF EVOLUTION.

By Mrs. ALICE BODINGTON.

NOTHING is more strange in the history of evolution than the persistence of rudimentary structures, which have lost all usefulness untold generations ago, and in many cases have become absolutely dangerous to the organism. Among these survivals, one of the most curious is the pisiform bone of the wrist, which careful researches in comparative anatomy show to be the carpal or wrist bone belonging to a long-vanished sixth finger. The oldest mammals discovered have never more than five fingers. It is necessary to go back to amphibian forms to find a sixth finger, yet all mammals possess the wrist-bone formerly belonging to it. The pineal gland, once supposed, for want of a better hypothesis, to be the seat of the soul, is a still more curious instance of survival, inherited probably from some transparent invertebrate ancestor with a median eye.

In mammals the pineal gland is deeply sunk beneath the highly developed intellectual portion of the brain, in a position utterly cut off from all possible communication with the outer world. Human physiology alone would have left us utterly without a clew as to the original use of this mysterious body. The secret was discovered after long and patient study of the brains of amphibians and reptiles. In these animals the intellectual portion of the brain (cerebrum) is in a very undeveloped condition, and

* Martineau, "Types of Ethical Theory," vol. ii, p. 374.

† "Daniel Deronda," George Eliot, vol. ii, p. 335.

the pineal gland is not covered. It lies just beneath the parietal suture, that portion of the top of the skull where the bones are still ununited in new-born children. In many reptiles, notably *Hatteria* (Fig. 1) and *Aurelia,* the pineal gland is found to be an optic lobe, united to the nerve-stalk of a true eye, richly supplied with a branched blood-vessel and nerve. Although this eye still possesses every essential part of a visual organ, yet degenerative changes have set in, which show that it has been long useless. In *Varanus giganteus* (Fig. 2), where a scale on the top of the head is fitted by its transparency and whiteness to act as a cornea, a large mass of pigment has accumulated just beneath, effectually preventing the possibility of any rays of light reaching the retina. In *Hatteria,* the eye appears fitted in all respects for vision, but a thick band of connective tissue has formed above it, and there is no modified scale. In both animals, *Hatteria* and *Varanus,* the rods and cones of the retina are strangely elongated in certain parts, as though from straining to catch the last rays of vanishing light. The rods of this portion are at least three times the length of the ordinary ones, and are in connection with a special group of nucleated cells.

In modern amphibians the greatly degenerated eye is separated entirely from the pineal stalk, though a connection still exists during embryonic life. But there is reason to think that among ancient amphibians—more especially among the labyrinthodonts—the pineal eye reached its very highest development, since it is found *outside* the skull. A large parietal opening, with roughnesses of the skull-bones serving as attachments for powerful muscles, is found in the great extinct amphibians and reptiles. The pineal eye was pre-eminently a sense-organ of pre-tertiary periods; it has probably never been functional since these remote ages, and yet its rudiments persist in every human brain. Moreover, these eyes are of the *invertebrate* type, pointing back to that conjectural molluscoid ancestor which was "transparent and had a median eye."

The records of pathology teem with instances of rudimentary organs which have lost their use and have become sources of danger and disease. I venture to think these facts are far too little known to those outside of the medical profession who are interested in evolution. It is not necessary to do more than allude to the "appendix vermiformis," since every reader of the "Descent of Man" will remember it as the typical instance of a mischievous rudimentary organ, given by Darwin.

All mammals possess, during their embryonic life, three sets of kidneys. The first set of tubules cease very early in fetal life to act as kidneys; they take on a new function of supreme importance, their ducts becoming the oviducts in most fishes, amphibians, rep-

tiles, and birds, and constituting the uterus and Fallopian tubes in mammals. In their earliest stage they are known as the *pronephros*, or "head-kidney," and answer to the permanent condition of the renal organs in worms; in their second stage they are known as the "ducts of Müller."

The second set of tubules constitute the *mesonephros* or Wolffian bodies; they act for a time as kidneys, and then become

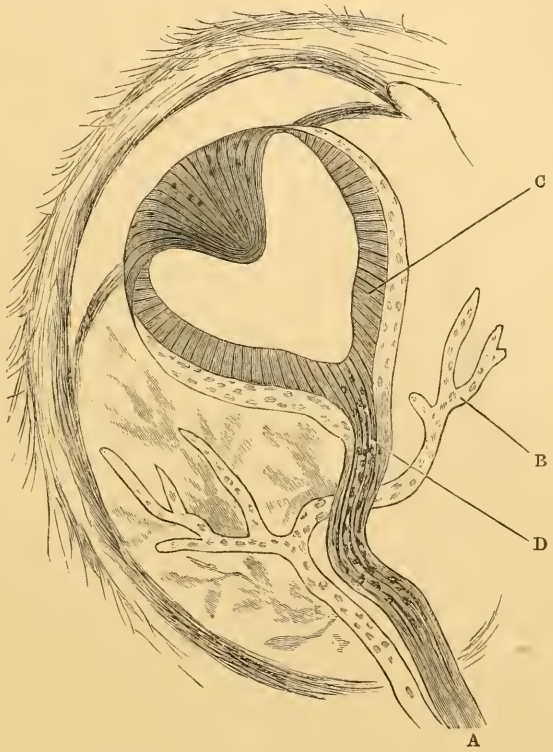

FIG. 1.—PINEAL EYE IN *Hatteria*. A, nerve; B, blood-vessel; C, retina; D, greatly elongated rods and cones of retina.

the ducts of the generative organs in the male. In the female they have no later functions, but their atrophied remains persist, and give rise to various forms of cystic disease. The upper division of the Wolffian duct, with its tubes, can be found lying above the ovaries, and is known as the *parovarium*. It is frequently the seat of degenerative disease, not only in human beings, but in lionesses, tigresses, and cows. The middle portion often disappears, but in the cow the whole tube persists, useless always, and mischievous very frequently. Both sets of tubules, those of the pronephros and those of the mesonephros, or, in other words, the ducts of Müller and the Wolffian ducts, persist throughout life in both males and females, one set becoming

highly developed, and the other atrophying, according to sex. This fact, of course, points back conclusively to primitive ancestors of fishes, reptiles, birds, and mammals, which were hermaphrodite. The argument for design is utterly put out of court by the awkwardness of the whole plan, and the disease and suffering caused in mammalian females by the ovaries having no

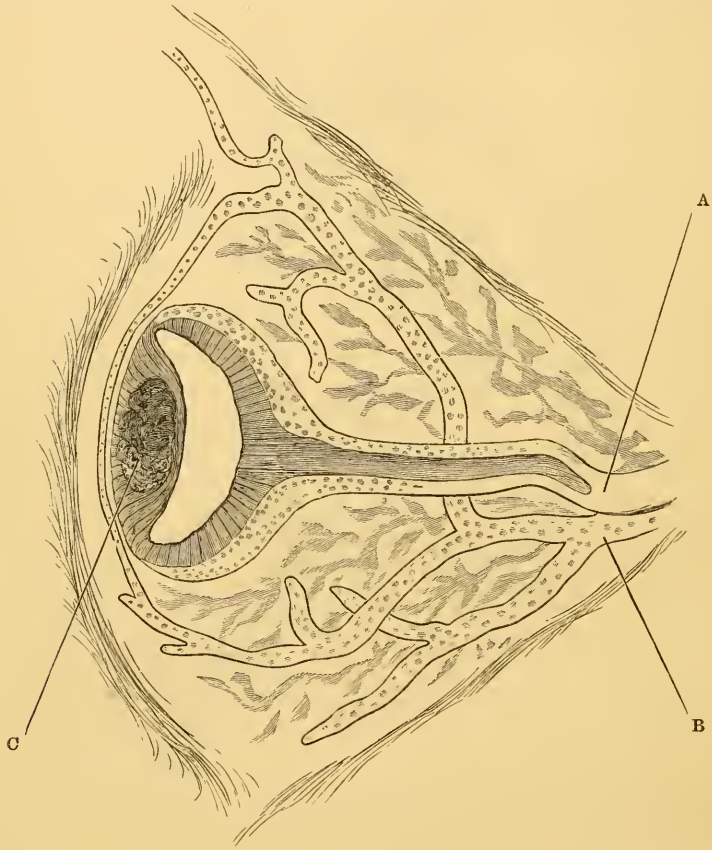

FIG. 2.—PINEAL EYE IN *Varanus giganteus*. A, nerve divided into three branches; B, blood-vessel branching and going round the eye; C, mass of pigment.

original connection with the uterus and by the survival of useless rudimentary organs. As a blind effort of Nature in the process of converting a hermaphrodite worm into a warm blooded mammal, the process has its wonderful and admirable side. The third set of kidneys are, of course, the permanent ones.

Prof. Cope, in his "Origin of the Fittest," draws attention to what he names the "law of acceleration and retardation." This law, though it may indirectly lead to the "survival of the fittest," is equally likely, through its blind action, to lead to the extinction of an animal which had once been the "fittest" in its

relation to the environment. There can be little doubt that the enormous tusks of the early elephants and the formidable canines of many early carnivores would enable them at first to distance all competitors. But the law of acceleration tended blindly always in the same direction, till the old elephants seem to have been weighed down by their extravagant tusks, and the most highly specialized of all carnivores had canines so long that they could not shut their mouths, and both speedily became extinct. The law of retardation exhibits itself in the teeth of the higher races of mankind in a highly inconvenient manner. The greatly developed brain requires all the available room in the skull; there is no space left for the attachment of muscles for a powerful jaw. Cooked food also causes a degeneracy in the development of the jaw. There is constantly no room left for either the wisdom-teeth or the second upper incisors; the wisdom-teeth are retarded, often cause great pain, and decay early. The second incisors appear in startling and unexpected places, and often (in America especially) do not cut the gum at all. Prof. Cope says that "American dentists have observed that the third molar teeth (wisdom-teeth) are in natives of the United States very liable to imperfect growth or suppression, and to a degree entirely unknown among savage or even many civilized races." The same suppression has been observed in the *outer pair of superior incisors.* This is owing not only to a reduction in the size of the arches of the jaws, but to *successively prolonged delay in the appearance of the teeth.* In the same way men, and the man-like apes, have fewer teeth than the lower monkeys, and these again fewer than the insectivorous mammals to which they are most nearly allied. When this difference in dentition has been established, civilized man may claim to place himself in a new species, apart from low savages as well as from the high apes.

SPIDERS AND THEIR WAYS.

By M. ÉMILE BLANCHARD,
OF THE FRENCH ACADEMY OF SCIENCES.

SPIDERS live in both hemispheres—from the torrid zone to the coldest regions. Over all the world they are distinguished by their singular aspects and curious habits. The largest and gayest-colored species are found in the tropics. In cold and temperate latitudes live smaller species and more tamely colored, which attract attention by other titles than that of their garb.

As classified by naturalists, the spiders compose an order of the class of *Arachnida.* They are the *Araneids,* a division so well characterized and perfectly circumscribed that it is suffi-

ciently designated when it is named. In these animals the head and corselet are confounded into a single mass, at the upper part of which is a kind of dorsal buckler, supporting in front the organs of vision. The eyes are generally eight in number, but are variously grouped, according to the types. Walckenaër, at the beginning of this century, made the disposition of the eyes a criterion of distinction between the genera and species. More recently, some remarkable coincidences having been noticed between the disposition of the eyes and the habits of the species, it became recognized that that feature could be relied upon in an animal wholly a stranger to determine the conditions of its existence and the way it got its living. The eyes do not turn in their socket like man's, for the cornea is only a tegumentary part which remains transparent. This immobility is an imperfection which is amply compensated for by the different orientations of the numerous organs, and their dispersion and grouping in such a manner as to respond to all the visual necessities of the animal. Being silent animals, and never having to answer to a call, spiders are backward in distinguishing sounds. This fact is assured by some features in their conformation. The romances that have been woven about their fondness for music are purely illusory. The disturbances which they experience at the playing of violins and pianos are simply effects of the vibration of their webs. Alarmed by it, they quit their hiding-places and run about in panic.

Beneath the front of the spider project two thick processes armed with a movable hook—the antennæ forceps—which conceal a poison-gland with a little tube running out to near the point of the hook. All who have seen a spider taking a fly have remarked how it stings its victim so as to kill it before introducing it to its mouth. At the edge of the buccal orifice of those species that live on fluids, exist only a simple tongue and two highly developed palpi behind it.

Spiders are differentiated from insects, which have six legs, by having four pairs of legs (Fig. 1). These members support hooks at their ends, which are working instruments of astonishing perfection. The body and limbs are covered with hair, fine down, and spines. These are the organs of touch, often of exquisite sensitiveness, planted in the skin. Under the microscope the downy hairs, which are hardly visible to the naked eye, appear fringed and bearded like incomparably delicate feathers. When we consider the habitual neatness of their clothing, to which grains of dust would so readily stick, we are satisfied that spiders are far from the hindmost in the care they give to their toilet. Their long, hooked legs perform an office that leaves nothing to be desired. At the extremity of the body may be found mobile articulated

tubes, having solid walls, and the end truncated with a membranous surface, riddled with holes. By these microscopic openings escapes the liquid which, hardened in contact with the air, becomes the thread out of which the web and the cocoon are made. Although it is cited as the type of fineness, this thread is formed of several fibers, which adhere together on issuing from the spinneret. It is unrivaled for evenness, delicacy, and power of resistance.

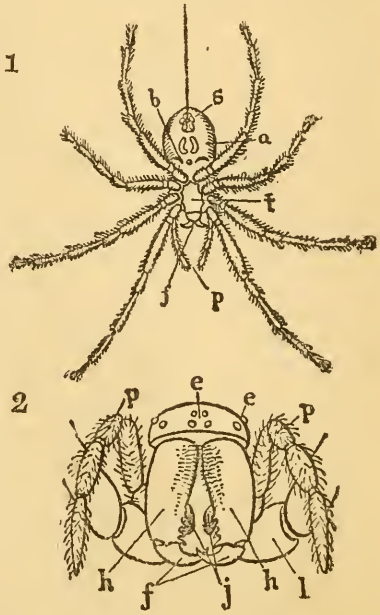

FIG. 1.—PARTS OF A SPIDER.

1. Under part of a spider's body—*t*, the thorax or chest, from which the eight legs spring, and to which the head is united in one piece; *f*, fangs; *p*, palpi or feelers attached to the jaws; *a*, abdomen; *b*, breathing slits; *s*, six spinnerets, with thread coming from them.
2. Front of spider's head—*e*, eyes; *p*, palpi; *l*, front legs; *h*, hasp of fangs; *f*, poison fangs; *j*, outer jaws.

The internal organization of the spider is even more admirable than the external parts. It would be hardly possible even to point out in this paper the most essential features of it. It would be going into long details to describe a muscular apparatus having a power of which the animal kingdom affords few examples, assuring wonderful precision and agility in movement; a nervous system whose enormous development accounts for faculties of a superior order; and a stomach of construction peculiarly adapted to a diet composed exclusively of fluids. It is written that spiders breathe by lungs. They have an aërial respiration, but it is by organs very different in structure from the lungs of man. They consist of minute pockets containing flattened sacks packed like the leaves of a book, through the walls of which the blood infiltrates, and the interior of which is penetrated by the air. Thus observed under water, the little sacks appear like so many sheets of silver communicating with the outside by slits at the bottom of the belly. Spiders have also a heart and a circulation of blood of the most complex character. The heart, which is on the dorsal face, is of an ideal anatomical structure, and long evaded the attempts of investigators to discover the vessels that carry the blood to the periphery of the body. The main vessels were finally traced out by means of colored injections in the European species, and the smaller ones afterward in the larger South American species. The study was a most charming one to

the young naturalist who made it about forty years ago, revealing a beautiful force-pump action, executed by instruments of infinite delicacy, and a power with which no machine of human invention can be compared.

Spiders are generally very prolific; yet we never see their numbers increasing considerably in any country. Fecundity is always proportioned to the dangers that threaten individuals. The young of these creatures so skilled in spreading nets are tempting bits to the appetites of carnivorous birds. All the spiders lay eggs, the larvæ from which have already the form and aspect of their parents. While as mothers they are incomparably careful, vigilant, and devoted, spiders show no feeling except for their own progeny. From the moment the young are in a condition to leave their mother, they become isolated from one another. When not under the influence of maternal instincts, the spider lives only for herself, ignoring the existence of every other individual of her race, which she devours pitilessly whenever she finds one within her reach. In such a world there are, in fact, no loves. The females are believed to be absolutely indifferent. If a male desires to contract a marriage, he proceeds with unexampled precautions, as if he knew he would be ill received. At last, if he is adroit, he will enjoy an embrace of an instant, and then, making the best use of his legs, which are longer than those of his ferocious spouse, he gets away as quickly as possible, otherwise his relative weakness would make him a victim. Poor male spider! He can not know the joys of paternity, but he can doubtless renew again and again his short instants of pleasure, for the two sexes are represented in the most unequal manner, the females being ten or twenty times as numerous as the males. The facts just related apply to spiders in general. But the various types furnish examples of special industries, aptitudes, and manners, on account of which it is necessary to divide our subject into special histories.

On the edge of the forest, among the rough-barked trees, or in dilapidated walls in the open fields, one may see in hot, sunshiny days numerous little spiders, scattered singly or gathered in groups, among which no hostility is manifested. Parts of their bodies are sometimes glossy and brightly colored, sometimes adorned with regular and elegant designs, forming a fine white, yellow, or red pubescence. They are extremely lively, and seek the brightest light. If the amateur tries to catch one he will be disappointed, for it will escape him and get out of the way at a bound. These spiders, jumpers, belong to the group which naturalists call the saltatory spiders (Fig. 2). Some of them are disguised, as if for protective resemblance, with the costume of a hymenopterous insect, or under an aspect resembling that of ants. Producing

only a small quantity of silk, they hide themselves in cracks in the walls or in fissures of bark in the shadow of the foliage, and make themselves a lodge out of a smooth or flossy tissue. At the laying of its eggs, the jumper shuts itself up in its shell. One species deposits its eggs without any covering; a more fortunate species incloses them in a sack with thin and almost diaphanous walls. Not having the faculty of spinning webs, the saltatory spiders are hunters, and have to fast if the weather is bad. On pleasant days they are to be found all around, and, having eyes all over the cephalic region, some of them quite small and others of enormous size, they can look accurately through all the surrounding space, which they explore slowly and with care. If a fly is in sight, the spider lances itself upon it with dizzy rapidity. It measures its distance so well that it rarely misses; but, if this should happen, no harm comes to it, for it has fixed a thread to its starting-point, which, unrolling as it leaps, prevents its striking upon the ground, and affords an easy road back to its position.

Fig. 2.—Jumping Spider (*Altus familiaris*).

Some spiders are wealthy, having at their disposal an immense quantity of textile matter, which is renewed continually; others produce but little, and have to live in cells under stones or dead

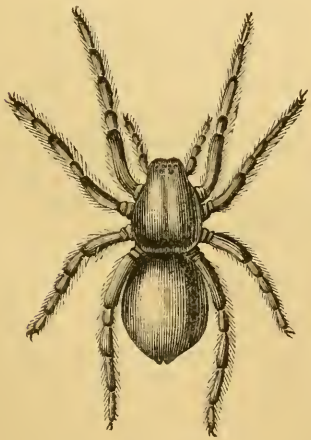

Fig. 3.—Wolf Spider (*Lycosæ fertifera*).

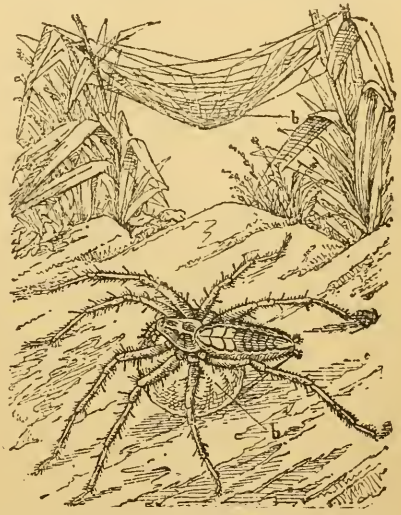

Fig. 4.—Hunting Spider (*Dolomedes mirabilis*), with a bag of eggs, *b*.

leaves, in the cracks of trees, and in walls. They have to hunt their game in the fields, along the edges of the water, or among aquatic plants. They are the *Lycosæ* (Fig. 3). The smaller, dark-colored species of central Europe have little to attract the eye; but occasionally the attention of the careful observer is directed

to one which is running rapidly along the road or trying to hide itself in the grass. It is carrying a pure white, round shell—the sack containing the eggs—in making which it has expended all the silk it had (Fig. 4). A mother of incomparable vigilance, homeless, its eggs laid and well protected in the silky walls of the shell, it does not abandon the cradle of its offspring for an instant. If we succeed in seizing one of the animals during its journey and take away its cocoon, the spider, usually so timid, instead of running away, makes a show of fight against the aggressor. If the cocoon is on the ground, it makes most earnest efforts to take it up and run away as quickly as possible. As soon as the young are hatched they attach themselves to the body of their mother, and she carries them till they are strong enough to hunt a prey, crafty enough to deceive an enemy, and ungrateful enough to cease to recognize a mother whose care has become of no use to them. Large lycosas adorned with lively colors inhabit southern Europe, Africa, and some parts of Asia. They are wanderers like their congeners of cold and temperate countries, and have the advantage over them of a longer existence and of having fixed retreats. They dig a cell in the ground, tapestry its walls, and weave a barricade of crossed threads across the entrance. Among them is the tarantula, concerning the effect of whose bite many marvelous but fictitious stories are told.

The smaller rivers of Europe are inhabited by an aquatic spider, the *Argyronetus aquaticus*, the first observation of which was a considerable surprise to the Père de Lignac, who discovered it and first described it. It was in 1747, and he was bathing in a river near Mans, when, he relates, "I was surprised by a wonderful sight: bubbles of air, bright as polished silver, appeared to swim around me and follow me. Their free movements, which were not determined by the motion of the water or by the levity of the air, declared that they were animated. My surprise shortly became astonishment when I perceived that they were large spiders whose bodies were enveloped in air." Two years afterward, Lignac obtained several specimens of the argyronetus, and made a closer study of them. While their nearly constant abode is the water, they are, like most other spiders, air-breathers; consequently they need some special provision for providing themselves with air while living under the water, and for this purpose they possess the art of constructing a kind of diving-bell. It is an interesting sight to witness one of them making his air-cell. Clinging to the lower side of a few leaves, and securing them in position by spinning a few threads, the spider rises to the level of the water, with its belly uppermost, and, doubling up its hind-legs, retains a stratum of air among the hairs with which its body is covered. Then it plunges into the water and appears as in the

first stage of the making of its silvery robe. Going immediately to the spot it had chosen, it brushes its body with its paws, when the air detaches itself and forms a bubble under the leaf. The

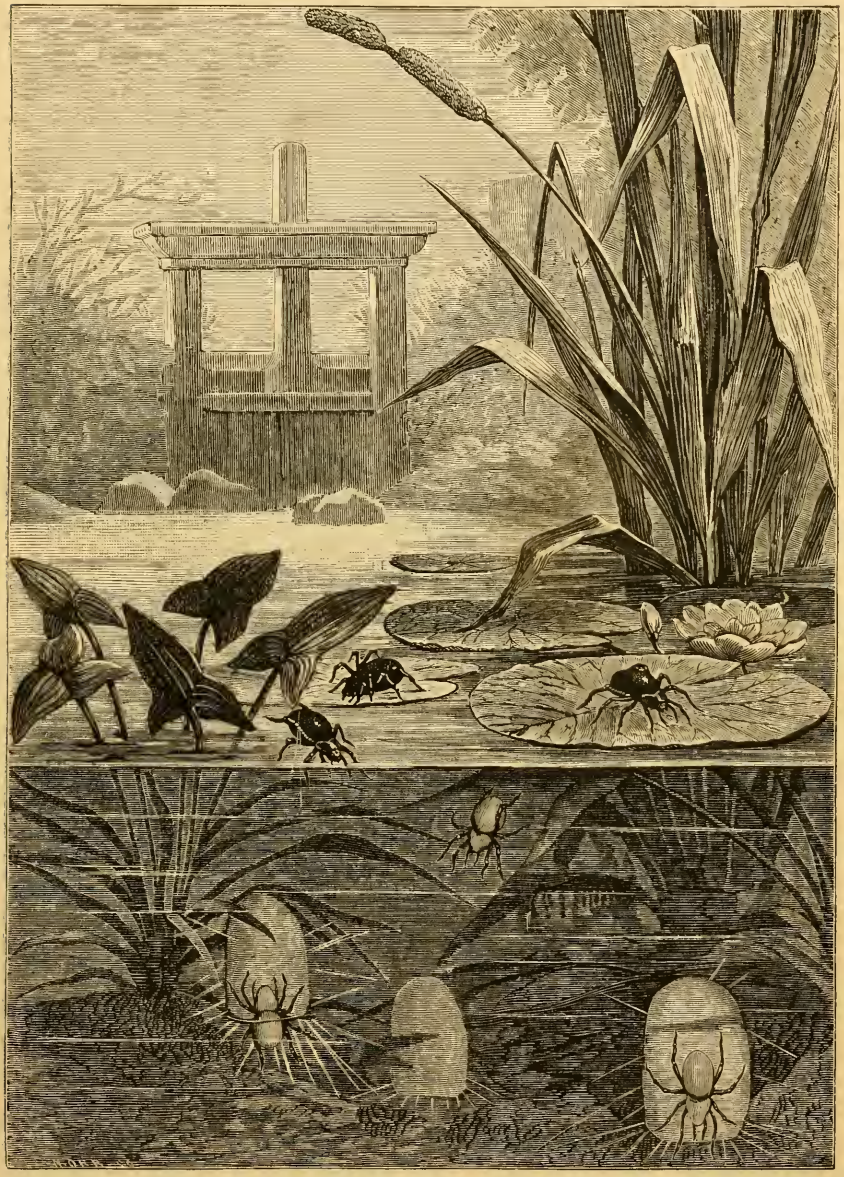

FIG. 5.—AQUATIC SPIDER AND ITS DIVING-BELL.

spider surrounds this bubble with the impermeable silky matter furnished by its spinneret. Returning to the surface, it takes in another layer of air, which it carries down and adds to the first

one, also extending the envelope over it. The process is kept up till the "diving-bell" has reached the proper size, and is finished. The ideal form of the construction is that of a thimble, but it often assumes an irregular shape, like an inverted sack (Fig. 5). When the spider has taken possession of its redoubt it remains quiet in it, head down, watching for the appearance of an insect. Perceiving one, it seizes it and returns to its lodge, which it has secured against intruders by spinning threads across it, to devour its prey at its leisure. The argyroneti being as ferocious as other spiders, the matter of marriage involves a grave crisis to the male. If he should present himself bluntly at the female's diving-bell, the result of the application would probably be fatal to him. But his instincts are adequate to the occasion, and he uses diplomacy, stratagem, and address. He makes a diving-bell near the female's, and adds a wide gallery between them. When his preliminary operations have been finished, he breaks through the wall of the female's lodge and surprises her into an embrace which is not always disagreeable to her. The young live for some time with their mother, whose solicitude for her little family is unremitting. When they have become strong enough, the young ones accept the struggle for existence and separate, each one going, as its parents did, to construct its cell and live a solitary life.

We now change our point of observation, and look at a spider that lives still another kind of life—as an inhabitant of our homes (Fig. 6). In a corner of the room under the ceiling is stretched a web, and on the web, watchful, stands a long-legged spider. It is the spider of all dwellings, and its presence is tolerated—the *Tegenaria domestica*. It has so pronounced a taste for dwelling-houses that it acts as if men's houses were built especially for it. A skillful weaver, it has at its disposal a quite abundant mass of silk. Its web is formed of an even material, which has been carded by tools of exquisite fineness, assuring the perfection of the work. When new, the web is a pure white; but it soon becomes soiled with dust and wears an unpleasant look, which, however, does not seem to give the proprietor any concern. The domestic spider is timid, and does not feel fully secure unless it has a good hiding-place to run to. It has reserved a vacant spot in the corner of the wall, and this is the road by which it steals away when it is alarmed. Beneath its web it has fixed a roomy hammock in which to take refuge. It deposits its eggs in a silken cocoon, which it hides under foreign bodies to conceal it from the greed of animals that would appreciate too well the delicious meats. During incubation, the

FIG. 6.—COMMON HOUSE SPIDER (*Tegenaria medicinalis.*)

mother watches the cocoon unceasingly, even forgetting to feed herself. When the young have escaped from their cradle, the starved mother returns to her web, where she sits and devours flies so numerously that the ground beneath becomes littered with their bodies. The domestic spider rarely inhabits the holes in rocks and the hollows of old trees, which are preferred by so many other creatures. Open-air species of the south and center of Europe, where the temperature is never rigorous, learn in the cold climates of the north, as in Scandinavia, to insinuate themselves into the houses—wise animals, that seem to know they will require a shelter from the cold.

We inhabitants of houses need not be above sharing our life with spiders. The part they perform is appreciated in the country, where they are not destroyed or disturbed in bedrooms or stables. The flies are a perpetual cause of torment to the people and to animals, and they perish in the webs of spiders, with perceptible decrease in their numbers. Spiders are, indeed, valuable servants given us by Nature.

On clear and sunny days, especially in the latter part of the summer, when a light breeze is blowing, long threads and flakes of a snowy whiteness may be seen floating in the air; or, covering the grass of the flowery meadows, they wave in the breeze and cause on the lawns shimmerings of strange effect. The peasantry of France call them the Virgin's threads. More accurately the naturalist would say they are the threads, abandoned as if to chance, of a kind of spider very common in the fields, which is called the gossamer spider. These spiders are wanderers, and frequent low plants and shrubs; small in size and loving the bright light, they wear lively colors which often confound them with the flowers and mask them from the pursuit of carnivorous animals. Their motions are abrupt and rapid, and their broad bellies give them a singular gait, something like that of crabs that we see running over the sea-beaches. They do not spin webs, but watch for passing insects, and, precipitating themselves upon their game with a sudden spring and extraordinary address, they rarely fail to secure it. The gossamer spider takes shelter under stones or plants or in holes. At the breeding-season they construct a sack to hold their eggs, and from that moment become sedentary and abstinent, watching over their posterity.

As day butterflies are gayer than night-moths, so do the epeïras show to better advantage than other spiders. They have for the most part either handsome colors or agreeable shades, and they hold the supreme rank as spinners. The European representatives of the group are modest in appearance, but in tropical countries the species to large size add luxury in dress. They are numerous enough on the globe to form a large family, that of the *Epeïridæ*,

which is composed of many genera (Fig. 7); but the family is one of which the members are all so alike that they all bear the same general signs and pursue the same kind of industry. The epeïras weave webs of enormous proportions, with large, regular meshes. As they work in broad daylight, among the most beautiful features of nature, it is possible to follow them in all their operations, which are performed as if expressly to charm a philosopher. The spectacle may be witnessed every summer in the parks and gardens of Paris in the webs of the *Epeïra diadema*, which sometimes obstruct the streets. This spider is of a reddish-yellow color, marked on the upper part in dark hues with a figure that has been compared with the cross of St. Denis. Posted on a branch of privet, lilac, or cytissus, it puts forth a thread of silk which lengthens out under the very eye of the observer, and, caught up by the lightest breath of air, at last fastens itself to the limb of a shrub, often at a considerable distance from the point of departure. Subsequently the spinner herself mounts the aërial cord, and fastens it to the place where it has fixed itself, adjusting its position if necessary. The most skilled balancers in the circus would lose in the comparison with the epeïra of the gardens, which manœuvres in every kind of attitude, upon a thread of extreme tenuity, with an ease and agility that defy all parallel. Threads carried to new points of support among the branches are adjusted so as to form a polygonal framework. This done, the spider returns upon the bridge which it first threw over, and stopping exactly in the middle, as if it had calculated the spot geometrically, it drops, head down, hanging to a thread which would divide the polygon in two. At the central point is fixed a fleck of silk that serves as a support to all the rays which diverge regularly to the periphery. The frame is made, but a final operation remains to be completed. An agglutinating thread must be stuck upon the rays, so as to form a spiral. The epeïra comes to the center of the web, draws the thread, which it attaches to the fleck of silk, and passes from ray to ray, describing circles away out to the exterior line of the frame. It will finish its work by returning from the circumference to the center, to interpose new circles between the former ones. It is impossible to realize a more sagacious combination to obtain a charming network, a lace of more admirable perfection (Fig. 8). Accidents will happen to the web of the epeïra. Gusts of wind during storms, or the stroke of a bird's wing, may mar its usefulness. The skillful spinner is only slightly affected by a disaster of the kind, for in less than an hour it will construct a new network. It is in cases where the web has suffered a single tear that

FIG. 7.—COMMON EPEÏRA (*Epeïra vulgaris*).

it displays the resources of its intelligence; it makes the repairs that are called for in a way that will command the attention of the intelligent observer. Particular tools are necessary for executing works demanding precision. Accordingly, the claws of the epeïra are of a much more complicated construction than those of

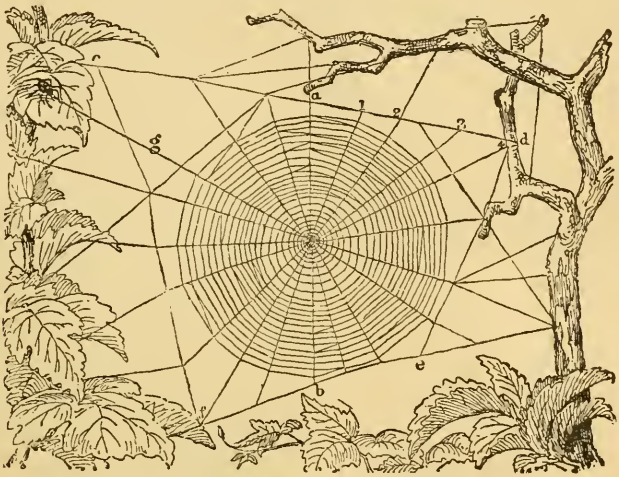

FIG. 8.—WEB OF THE GARDEN SPIDER.

other spiders. One of them is cleft so as to form a fork, with which the artist is able to hold its threads and put them precisely where they are wanted to be.

In attack, the epeïra holds itself in the center of the web, head down. If an insect strikes against the network, it precipitates itself upon the game, which instantly finds itself held and tied in such a way that it can not escape. At the end of the summer this garden-spinner is depositing its eggs, and incloses them in a cocoon made of a different kind of silk from those which enter into the construction of its web. The poor mother, who must die in the autumn, takes care to hide the cradle of her offspring in as secluded a place as possible. The young spiders, when hatched in the spring, remain together for several weeks as one family, after which they scatter and live isolated after the general manner of the daughters of Arachne.

In various parts of the East Indies and in the islands of the Pacific Ocean there are brilliant epeïras of superb proportions. The species are numerous, and the individuals occur, in many places, in multitudes. Some of these spiders prefer situations over water-courses, where they offer the most enchanting spectacle to the eye. In the midst of the most luxuriant and intricate vegetation the epeïras stretch their nets from the tops of the highest trees from one side of the river to the other. The traveler, looking up from his canoe beneath, views with admiration these delicate

aërial structures, succeeding one another at short intervals and giving curious effects to the landscape. The great spider may generally be perceived on each of these nets, either motionless or in a state of high excitement, according as it is waiting for game

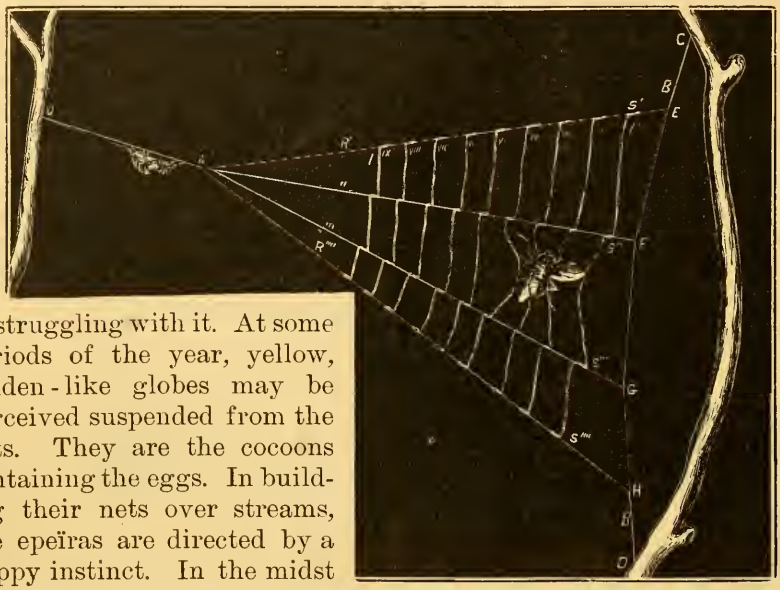

Fig. 9.—Net of the Triangle Spider (*Hyptiotes Americanus*), about one half the usual length. The spider shown of the natural size.

or struggling with it. At some periods of the year, yellow, golden-like globes may be perceived suspended from the nets. They are the cocoons containing the eggs. In building their nets over streams, the epeïras are directed by a happy instinct. In the midst of a peculiarly bushy vegetation, they seek out broad, open spaces suitable for their establishments. In such spaces they are safest from their voracious enemies, and are at the same time conveniently situated to capture the insects that are their food. Not only are mammals and insects, lizards and birds fond of spiders, multitudes of people regard the handsome spinners as delicious meat. A large species, very abundant in the Polynesian Archipelago, is called the eatable epeïra (*Epeïra edulis*), and is much sought for by the islanders.

The epeïras of Madagascar and the Mascarene Islands, according to the descriptions of Captain Dupré, are among the largest and handsomest of their kind. They build vertical webs which they attach to trees and shrubs by long threads having great power of resistance. The black epeïra predominates in the island of Réunion, the gilded epeïra in Mauritius—a magnificent animal, whose body, two inches or more in length, bears on the back a large space of bright yellow, relieved by two rows of black dots. The Madagascar species, which the Malagasy eat with relish, is yet more highly distinguished by the gayety of its dress. Its black dorsal buckler is clothed with a silvery pubescence; on its abdomen are harmoniously combined the colors of ebony, gold, and silver, and its legs are a fiery red. The disproportion in the size

of the two sexes, marked enough in all spiders, is greatly exaggerated in these two species, of which the male is a mere myrmidon by the side of the female (Fig. 11).

In the Mediterranean countries, pretty epeïras, mostly of a silvery luster, fabricate a web with regular meshes and having a singular attachment, the use of which was first discovered by M. Vinson by observing one of the species common to Mauritius and Réunion. The webs are distinguished by a single silvery thread of enormous size compared with the other threads, running across them in zigzag folds. Not having seen any use made of this cable, M. Vinson cut it several times. It was replaced in a few hours. Flies and small insects flying against the web were seized and bound without calling this thread into use. Finally, a large grasshopper was ensnared, when in an instant the spider undid the large thread and quickly bound up in it the nimble giant, against which cords strong enough to hold flies would count for nothing. This, then, was its purpose, and it is hardly possible sufficiently to admire the instinct that prompted the preparation of it.

Fig. 10.—Supposed Cocoon (Egg-Case) of the Triangle Spider (*Hyptiotes Americanus*). *A*, the cocoon, of natural size, hung by thread-lines between hemlock twigs; *B*, the cocoon enlarged, seen obliquely, so as to show the triangular base.

While most of the epeïras are lovers of the daylight, a few of them are active at night. Some species of the Mascarene Islands and Madagascar weave webs in the twilight which they destroy at dawn. During the day they hide under heaps of leaves which they have gathered up into a kind of nest. Their webs are coarsely spun, as becomes a nomad who has to pitch his tent anew every night, and has no time to waste in elegance. Some of them, however, are not satisfied to pass their days in heaps of leaves, but construct a kind of nest out of thin silk as a more eligible habitation. Of these more refined spiders, the *Epeïra Borbonica*, with its cherry-colored body and lustrous black legs, fixes its night-web and its day-tent to the roofs of houses, the projections of rocks, and the branches of large trees. The much larger lilac-

colored *Epeïra livida* lives in similar luxury under the roofs of the Malagasy houses of the province of Imerina.

Leaving the grand epeïras, we may find, among vegetation and on walls, spiders whose weak proportions suggest their classifica-

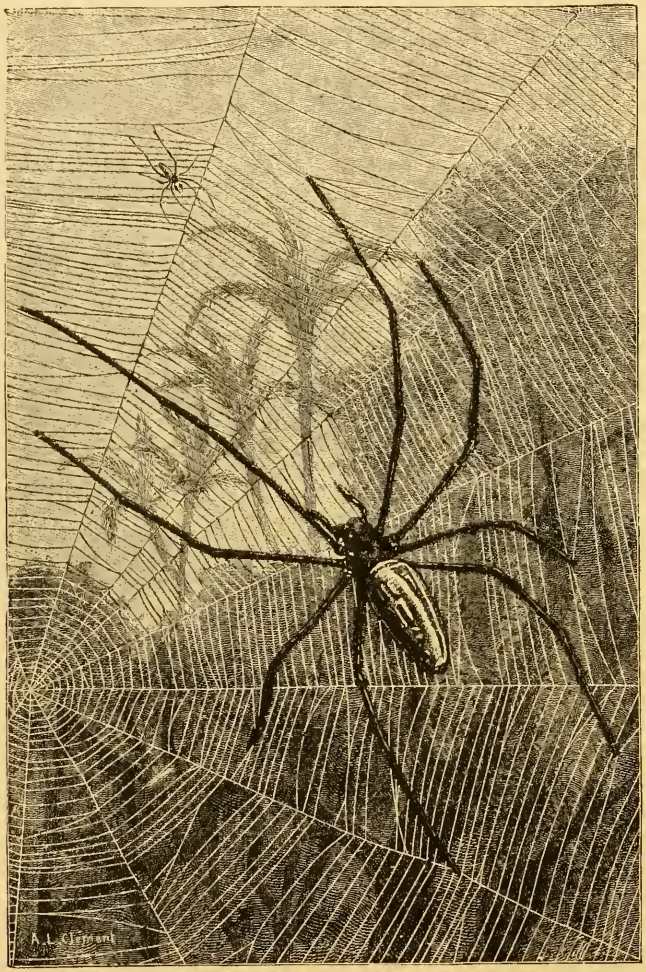

FIG. 11.—*Nephila Chrysogaster*,* MALE AND FEMALE (one half natural size).

* This spider, whose name translated is the golden-bellied *Nephila*, has been described in "La Nature," by M. Maurice Maindron, from his observations of it in Java, the Moluccas, and New Guinea. Its nests are quite numerous in Java, and occupied several metres in the forests. They are constructed at an elevation above the ground corresponding with the height of a man's head, and are frequently annoying to persons passing through the wood. M. Maindron found the threads strong enough to pull off his *salacko*, or cork helmet, whenever it became entangled in them, and hold it suspended in their meshes. It is not unusual for the casual intruder into the nest to carry off the spider on his face, where the animal makes itself perfectly at home, and will promenade at its leisure over your face, shoulders, and arms, and will walk quietly the length of your body, in no seeming hurry to get away. —EDITOR.

tion among the most insignificant of beings; but they play an important part in nature, and often serve the interests of cultivators by causing the destruction of numerous noxious insects. They are the *Theridions.* Some of them form a web with wide meshes, while others weave a regular tissue that rests directly upon the grass or is fixed upon other plants. They usually lurk under their webs. The females make several cocoons for their young and keep them in their nets. Some species build a dome-shaped shelter out of foreign bodies fastened together with threads. Sometimes the grapes in vineyards are covered with a web so fine that it escapes notice, and the grape is swallowed, web, spider, and all. Walckenaër named this species *Theridium benignum,* considering it beneficent. It lives in part on insects injurious to the vine, and its little web protects the grapes against the attacks of animals fond of good fruit, but which will not venture to embarrass their mouths with spiders' webs.

Spiders very generally take pains to isolate themselves from one another. It is a matter of instinct. Were it not so, there would be perpetual slaughterings. Two spiders meeting never fail to be taken with a terrible desire to devour each other; but there are curious exceptions to this rule. Minute spiders, called *Linyphia,* are not afraid to attach their nets to the large-meshed webs of the great epeïras. Some linyphias, like the *Linyphia argyroides,* are of curious forms, from four to six millimetres in size at the largest, and are adorned, on a reddish-brown ground, with golden and silvery colors that shine with a bright luster. They may be remarked in the south of Europe and in Africa, stationed on a little net within the meshes of the web of a superb epeïra. A feature that adds to the singularity of the grouping at a certain period is the presence of the cocoon of the linyphia, hanging by a slight thread from the web of the larger species; but treachery sometimes invades this association. An epeïra and a linyphia had lived in the best of relations. The larger spider was taken away from her abode, leaving the cradle of her family without defense. On the next day the linyphia had opened the cocoon and was quietly eating the half-hatched epeïras.

There are legions of spiders, superior to all the others, living in the shade, which are distinguished in an extraordinary degree by their habits and instincts, and perhaps by their intelligence. These species do not make webs, but have some of them only a shift for a refuge, others simple abodes, and still others quite sumptuous habitations. In temperate climates many of them construct in secluded spots, from a fine white silk, well-finished tunnels in which they make a nearly permanent residence. The *Segestria* are the most important members of this group. The Florentine or perfidious segestrium, the larger species of the genus,

is of a rich black color, with antenna claws of bright emerald-green. It is spread through most of Europe, and lives under cornices, in the cracks of walls, and clefts of rock. While spiders of every other type have eight eyes, these tubicolar species have only six, those which look backward being wanting. They would be of no use to an animal living in a hole which is closed at one end.

In the intertropical regions, especially in the Antilles, Guiana, and Brazil, there live enormous spiders which the European

Fig. 12.—Bird-Eating Spider killing a Humming-Bird.

colonists call spider-crabs, and naturalists *mygales*. In them, suppleness and agility are united with muscular strength. Of all the representatives of the race which now engages our attention, the greatest physical power is exhibited in these. The mygales

produce but little silk, only enough to give them a foothold on a vertical plane, to bar the opening of their holes, and to bind their prey. Their simple claws are not adapted to the purposes of tools. They are hunters, and live in the hollows of trees, which they do not leave, except to go on the chase. Their eyes are not distributed over the body, like those of other spiders, but are grouped upon an eminence in the middle of the cephalic region, two in front, two on each side, and two looking hindward, in such positions as to command simultaneous views in every direction. The larger, dark-colored species go abroad usually in the dusk and at night, and capture with equal boldness large insects, small lizards, and humming-birds (Fig. 12).

The abbé Sauvage, of Madrid, in 1768, astonished the French Academy of Sciences with the declaration that he had found a spider "that did not stretch any kind of web, but hollowed a burrow in the ground like a rabbit, and added a movable door to it." The species had been observed on the road-sides, around Montpellier, and on the banks of the little river Lez. A little while previously, a traveler, Patrick Browne, had found a nest of similar construction to this, but less perfect, in Jamaica. Since the last century these animals have been called in France, mason-spiders; in England, trap-door spiders. Judged by the organism as a whole, they appear to be related to the mygales, but they present several differences in detail. Like the larger mygales, the trap-door spiders have stout bodies, large legs, eyes grouped on an eminence, and a dorsal buckler; but in the lower parts of their forceps-antennæ they have a row of points, a kind of rake, with spines on their paws, and teeth in their claws, which give a resemblance to microscopic combs. These are tools, working instruments, of which the mygales, compelled to find a home where they can, are destitute; naturalists call these spiders *ctenizas*.

The domiciles or burrows of the trap-door spiders are so well disguised that only an experienced observer can distinguish their presence on the surface of the ground. But, while without everything is as far as possible from suggesting a comfortable habitation, within the hole reign neatness, elegance, and graceful adjustments. These structures abound in the south of France and in nearly all of southern Europe. In compact earth, free from stones and gravel, they are built quite close to one another. Each one of them consists of a vertical hole or pit (Fig. 13), of a size proportioned to that of the architect, the cylindrical tube flaring toward the mouth. The walls are tapestried with the softest of satin, prepared from the silk which the animal spins. The entrance is most skillfully closed by a solid door, which can not easily be broken or pushed in. It is made of the material thrown out during the digging of the pit, the earthy particles being held together by the

silky matter. The doors are cut in a conical shape, to fit the flare of the cylinder, and will not yield under pressure from without. The exterior of the door is uneven and rough, like the ground round it, whereby the attention of enemies is diverted. Inside it is tapestried like the nest itself. The hinge, made of a compact silk, possesses great resisting power, and such elasticity that the trap infallibly falls back as soon as it ceases to be held up. The

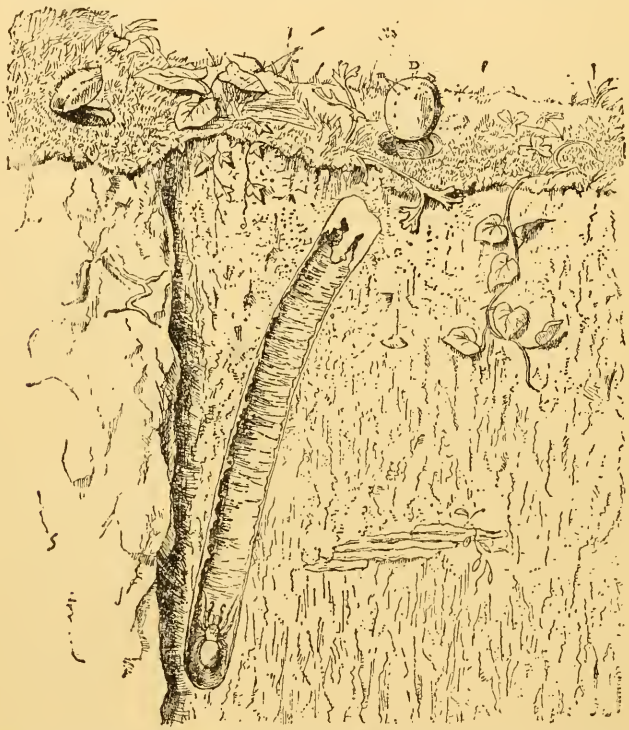

FIG. 13.—NEST OF ONE OF THE TRAP-DOOR SPIDERS (*Moggridge*). *D*, the door which closes naturally by its own elasticity and weight; *m*, marks of the spider's claws when she has held it down from inside.

place of a lock or bolt is taken by a series of little holes, like needle-pricks, arranged in a circle around the side of the door opposite the hinge. When the trap is down, the closing is so exact that the most delicate instrument can not be introduced into the interstice without danger of injury. If one tries to raise the trap, the spider, clinging to the walls of the pit, and inserting its claws into the holes of the cover, will make the most desperate efforts to keep it shut. In the evening, the spider comes out stealthily from its retreat, and goes to hunt its game in the fields. Having finished its meal, it returns to its home, lifts the trap-door with its claws, and disappears from view in an instant.

A much larger and finer species of cteniza than the one just

described inhabits Corsica, Sardinia, and the parts of Italy near Mentone. Its nest, usually built in the light red clay of the region, is a beautiful construction, from four to eight inches deep, and about five eighths of an inch in diameter. Like the others, these nests are usually grouped in considerable numbers, very near to one another; sometimes, indeed, they are contiguous. The first admirers of the art of these creatures, the "pioneer ctenizas"—the Italian Pietro Rossi, and the Frenchman Victor Audouin—were struck with this association, so like that of villages; for we do not usually think of spiders without conceiving them as solitary and isolated. But it is evident that these trap-door spiders do not hold that antipathy toward their fellows by race which is the rule in the Arachnidan world. While everywhere else, with this strange race, the association of males and females is only for an instant, and is accomplished by a surprise, the manners of the ctenizas are more gentle and like those of birds. The chief difference is that, while the bird builds a nest for its family, the cteniza has a permanent home in which to accommodate its offspring. The ctenizas behave as if they knew what was to occur. At the time of reproduction, a male is admitted to the residence of the female, and becomes a guest there. The eggs having been laid, the couple appear to watch together over the deposit with the best understanding, and an equal solicitude. But when the young have become large enough, like young birds, they leave the nest and assume their independence without any further concern for parental cares, and the father and mother separate, to resume the freedom of isolation. And when we observe a male in the cell of a female, we are inclined to think that many doors are open to him; for females are numerous and males are rare.

Mr. Traherne Moggridge undertook to obtain a deeper view of the life-secrets of the mason or trap-door spiders. As they work at night, it was not easy to surprise them when active in their labors; but much may be accomplished in the way of discovery by the exercise of patience and sagacity. Mr. Moggridge found it a good plan to follow the spider in building a new abode when its old one had been demolished. It executes its task speedily, without neglecting any detail, as if in obedience to a perfect method. The favorite places are the slopes of terraces and the banks of rivers; choosing a time, if it can, when the ground is moist, it clears away the earth with its claw-rake, and marks out the cylindrical hole. If there are any places in the walls that lack cohesion and where a slide may be anticipated, the animal, as if it were a graduate from a school of engineers, consolidates the parts with silk and weaves in successive layers the pretty satiny texture with which its house is to be adorned. It pursues its task in this way till the determined depth is reached. The tube having been con-

structed, the mason stretches a little web over the opening, sticking to it such particles of earth as it may find within its reach. A new sheet of silk is stretched over this, and a second layer is formed; and the process is repeated till the trap-door has obtained the requisite thickness. Then it shaves the edges to make the contours even, and the door is finished. If we compare several nests of the same species, we shall notice considerable differences in the merit of the work, from the greatest excellence down to comparative inferiority. Sometimes we find nests with two doors and two vestibules. In the majority of instances of this kind, one of the trap-doors has been condemned. Sometimes the hole is provided with an ascending annex, not opening out upon the surface but provided with an interior door separating a smaller chamber from the main abode. This puts the spider to advantage against an enemy that may have gained access to the main chamber. The ctenizas take a variety of precautions against being discovered. Sometimes the trap-doors are disguised by looking in no way different from the ground around them. In other places they are concealed by means of moss, lichen, grass-blades, bits of straw, or whatever foreign bodies it may be convenient to strew around and over them. The masons are very diligent in their work. If one of them is deprived of his retreat, he will replace it in a night or two. But, notwithstanding their skill in construction, the best observers affirm that young spiders will not abandon a nest when it has become too narrow for them. They have the art of enlarging them so that they shall always be at ease within. The Austrian naturalist, Erber, met in the island of Tinos, in 1868, a previously unknown species. He studied its habits and found that it came out of its nest every evening to make an excursion, but left its door open, fastening it back to some stone or plant-stalk, protecting the entrance by weaving over it a net which it destroyed on its return in the morning.

The trap-door spiders have been seen in many parts of the globe, but usually in countries where a high temperature prevails. They are abundant in the countries around the Mediterranean, and have been observed in the Austral lands and in America. A species of very fair proportions, the *Cteniza Californica,* lives in California. A living specimen was kept and observed by M. Hippolyte Lucas for four months in the *Muséum d'Histoire naturelle.* The observer succeeded in opening the door of the cell and presenting the spider with a fly. The cteniza, hungry after a long voyage, seized the fly at the entrance of its burrow, but retired to the back upon the attempt being made to draw it out; and it continued suspicious, even toward its friend. One night, after it had had a few days of good feeding, it sealed the circumference of its

door, which it was annoyed to see opened by a stranger, and on the next day a new trap was constructed at a short distance from the former one. Had the creature thought that the new door would be unknown to the person who had disturbed it at the old one? When its last hour was approaching, the California mason crept slowly out from its home, and was afterward picked up dead on the ground at some distance from the spot.

In the world of spiders, as we have seen it under its varying aspects, a fundamental unity of character prevails in essentials, with an attracting diversity in secondary things. While the creatures are highly organized, they are very unequally endowed in fortune, in physical advantages, and in resources to help them in the struggle for existence. Notwithstanding their sagacity, they do not inspire the interest or sympathy that is bestowed upon insects that work in common and form social organizations. In their solitary life they represent individual egotism in its most absolute sense. Yet they are all alike watchful mothers, displaying an unparalleled solicitude for their offspring—a solicitude which we might even call tenderness. While with most other animals the sexual relations promote kindly and social qualities, the relations between male and female spiders are generally very much strained. Yet, as if Nature repelled a rule absolutely without exception, we have witnessed some pleasant instances of union among a few privileged species. The instincts of spiders have revealed themselves in striking forms, while some signs of a higher faculty have also appeared. And does not a being which shows such just appreciation of situations, and can repair damages to its structures in so irreproachable a manner, show evidence of a reasoning faculty? In truth, observation of the acts and faculties of the humblest creatures is not without use in adding to our knowledge of the wonderful phenomena which are the subjects of psychology.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE advance that has taken place in scientific and in all thought is wonderfully illustrated in the history of the authorship of the "Vestiges of Creation." Robert Chambers's connection with the work was well understood in private circles when the book appeared, but was never avowed; and he was obliged to forego a candidacy for public office for fear that the matter would be stirred. This was because there was danger that the house of the Chambers's would be ruined if it became publicly known that one of its members was the author of so pernicious a book. Compare this situation with that of the present, when evolution has become a general scientific fact, exerting its acknowledged influence on religious thought, almost without longer exciting remark!

WHAT IS KNOWN OF THE EARTH.*

By Lieut.-General R. STRACHEY, F. R. S.

SO thorough has been the success with which recent labors of geographical research have been prosecuted, that it would now be hardly possible to describe what is known of the earth, otherwise than by pointing to what is still unknown, and this might be summarized in a very few words.

Besides the interior of Borneo and New Guinea, and the portion of Central Africa where Stanley is for the present moment lost to view, no considerable part of the earth's surface is unexplored, with the exception of the polar regions, which have till now proved inaccessible. The maps of the interior of Africa now supply trustworthy representations of a vast system of rivers, lakes, and mountains, till recently wholly unknown to the civilized world, and what remains to be done is little more than to fill in the details of well-ascertained large outlines. Australia has been crossed and recrossed in many directions. The darkness which so long enveloped Central Asia has been entirely cleared away, and, though parts of Thibet are yet to be visited, the true nature of the central plain lying between that country and Siberia is completely known. The geographical features of North America are little less perfectly mapped than those of Europe; but large parts of the interior of South America, much of which is covered by forest, are still unsurveyed. The southern border of the North Polar Sea, and the very complicated system of islands and channels along the northern margin of the American continent, between Bering Strait and Greenland, have been precisely delineated, and the boundary of the same sea along northern Asia has also been determined. The highest northern latitude reached is about 83½° north—that is, within five hundred miles of the pole. The nearest approach to the south pole has been in 78° 11′ south, but the difficulties arising from climate have till now stood in the way of any satisfactory survey of the land seen at some few points in the antarctic area.

The figure of the earth, and its existing features, have had their origin in a former state of the planet, during which it has been subject to the gradual changes that accompanied its cooling from a previously much higher temperature. The forces of nature which are still at work, including the most wonderful of all, life, have operated upon the globe while it thus passed through the stages which have led to what it now is; producing varied conditions of surface, from which have arisen, as direct consequences,

* From "Lectures on Geography," delivered before the University of Cambridge.

differences of climate, and corresponding variations in the forms and distribution of living creatures, vegetable and animal. Thus it is that while every part of the earth has its own characteristics, the general system of nature is one and the same everywhere; the special characters of the several regions being due to the action of local features or conditions, which are no sooner called into existence than they in turn become secondary efficient causes of the infinitely varied phenomena that our globe presents to us. In this manner has been evolved the face of nature as we now see it; nature which, working with never-varying forces, appears to man in the present as his type of stability, while it is constantly leading, through ever-varying forms, from the hidden shapes of an impenetrable past to those of an unknown future.

The influence of the movements and figure of the earth may everywhere be traced among the phenomena brought to our knowledge by the more and more complete exploration of its surface. The daily and annual motions of the globe, subject to the effects of the spherical form of the earth and the direction of its axis of rotation, determine at all parts of its surface the amount of heat and light received from the sun, and thus regulate all the conditions of existence upon it; they give rise to the varying length of days and of seasons at different places, and to a multitude of recurring phenomena which characterize or influence the animate and inanimate world. In whatever direction we turn are to be found alternations of what may be termed terrestrial work and rest, day and night, summer and winter, periodical winds extending over longer or shorter periods, seasons of rain and dry weather. The tides of the ocean, and the less apparent though not less regular periodical oscillations of the atmosphere, as well as the little understood variations in terrestrial magnetism, are consequences of the same general causes.

The remarkable force inherent in the globe, known as terrestrial magnetism, which gives a determinate direction to a freely suspended magnetic needle, and is of inestimable value to man, has long been the subject of observation and study. It is now established that there are two magnetic poles, one in each hemisphere, at which the needle would point vertically upward and downward. Their position, which is not coincident with the geographical poles, is found to have varied according to some yet unknown law. In the year 1878 the northern pole was in latitude 70° north, longitude 96° west, and the southern in latitude 73½° south, longitude 147½° east. Between these poles, a line that has been termed the magnetic equator, where the needle assumes a horizontal position, is found to pass round the earth, following an unsymmetrical line, which in 1878 lay almost wholly to the north of the terrestrial equator in the hemisphere east of Greenwich,

and to the south of it in the western hemisphere. It further appears that the magnetic force is not evenly distributed on the earth, and that the points of maximum intensity do not coincide with either of the magnetic poles. In the northern hemisphere there are two foci of maximum force of unequal intensity, the most powerful lying at about latitude 52° north, longitude 92° west, near the great American lakes, the weaker in latitude 65° north, longitude 115° east, in Siberia. For the southern hemisphere, the available data are far less numerous, and the determination of the foci of force is less reliable. It is, however, believed that here also there are two points of maximum, of nearly equal power, and not far removed from one another, one in latitude 65° south, longitude 140° east, the other in latitude 50° south, longitude 120° east. The unit by which magnetic force is measured has been assumed, adopting English standards of weight and length, to be that which would impart to a weight of one grain a velocity of one foot in one second of time. On this scale the magnetic force, where least, is found to be 6·0; the northern maxima are 14·2 and 13·3 respectively, and each of the southern 15·2. The declination, or variation of the direction of the needle from the true meridian, is a consequence of these unequal forces operating upon it, the westerly or easterly tendency of the needle (as the case may be) following the geographical position of the place of observation in its relation to the several foci of force, with a general result of considerable complexity. Up to the sixtieth parallel of latitude, north or south, the declination, whether easterly or westerly, rarely exceeds 30°; and, speaking generally, it is easterly in the Pacific and westerly in the Atlantic and Indian Oceans. Near the poles, where the dip becomes high, the directive force of the earth's magnetism becomes much reduced, and the magnetic needle becomes comparatively unreliable and of little use. The nature and mode of operation of magnetism, and the allied phenomena of electricity, continue to be subjects of speculation, no explanation of them having yet been proposed, such as that which refers heat and light to the vibrations of an elastic medium. Our knowledge of the phenomena of terrestrial magnetism therefore still remains in the empirical stage; they are, however, held to show that the earth's magnetism is distributed through its mass, and that the magnetic force either wholly or mainly resides in the interior, and can not be attributed to external influences, though it may be affected by them. Whether or not geographical features have any influence on the distribution of this force is doubtful. Observation shows that all the elements of the earth's magnetism not only vary from place to place, but from time to time; the variations being in some cases periodical and dependent on the time of the day or the season of the year,

and others extending, with no apparent tendency to periodicity, over considerable lengths of time. The manner in which these variations occur is still a matter of investigation, and their causes are doubtful, but the diurnal and annual changes are probably connected with changes of the temperature of the earth or its atmosphere, and may be influenced by geographical conditions. The non-periodical changes that have been recorded are very large. These variations have been attributed by some to changes going on in the condition of the interior of the earth, and by others to external influences; but they continue to be among the most obscure of physical phenomena. Besides the variations above mentioned, there also arise other irregular disturbances of the indications of the magnetic needle, of short duration, which are sometimes spoken of as magnetic storms. They occur with a frequency which shows a tendency to periodicity, diurnal or annual, and often almost simultaneously at distant parts of the earth, with nearly identical effects, and with a marked increase in intensity with increase of latitude. They likewise exhibit a period of increase and decrease coinciding with that observed in the sun-spot area, thus giving additional reason to connect them with modifications of the magnetic or electric condition of the earth or atmosphere arising in some manner from the action of the sun. The probable connection of these disturbances with the electrical condition of the atmosphere is indicated by their frequent occurrence simultaneously with appearances of the aurora, and with electrical earth-currents. The frequent, if not continuous, display of the aurora in the vicinity of the magnetic poles, further suggests a relation between the electrical and magnetic conditions of the earth. The true nature of all these phenomena is, however, still very imperfectly ascertained.

A very little observation and thought threw discredit on the ancient cosmogonies, and showed that they failed to give any satisfactory solution of the problems submitted by the advance of knowledge. If the extravagant myths of Asiatic origin, which peopled the earth millions of years ago with races of anthropomorphic demigods, and heroes descended from the sun and moon, could not bear the test of facts, neither have those traditions fared better which unveil the earth fully equipped with all the present forms of life and specially prepared to be the dwelling-place of man, some few thousand years ago. Precise observation has now supplied satisfactory proof that the earth's surface, with all that is on it, has been evolved through countless ages, by a process of constant change. Those features that at first sight appear most permanent, yet in detail undergo perpetual modification, under the operation of forces which are inherent in the materials of which the earth is made up, or are developed by its

movements, and by its loss or gain of heat. Every mountain, however lofty, is being thrown down; every rock, however hard, is being worn away; and every sea, however deep, is being filled up. The destructive agencies of nature are in never-ceasing activity; the erosive and dissolving power of water in its various forms, the disintegrating forces of heat and cold, the chemical modification of substances, the mechanical effects produced by winds and other agencies, the operation of vegetable and animal organisms, and the arts and contrivances of man, combine in the warfare against what is. But hand in hand with this destruction—nay, as a part of it—there is everywhere to be found corresponding reconstruction, for untiring nature immediately builds up again that which it has just thrown down. If continents are disappearing in one direction, they are rising into fresh existence in another. Though the ocean tears down the cliffs against which it beats, the earth takes its revenge by upheaving the ocean's bed.

When we look back, by the help of geological science, to the more remote past, through the epochs preceding our own, we find complete evidence that the globe has passed in succession through an infinitude of anterior states, by means of small modifications extending over a vast period of time, but not differing in essentials from those which we now see to be going on. There are still preserved to us the remains of land and marine plants and animals—which lived, produced other generations, and died—possessed of organs proving that they were under the influence of the heat and light of the sun; indications of seas whose waves rose before the winds, breaking down cliffs, and forming beaches of bowlders and pebbles; of tides and currents spreading out banks of sand and mud, on which are left the impress of the ripple of the water, of drops of rain, and of the tracks of animals; of volcanoes pouring forth streams of lava; and all these appearances are precisely similar to those we observe at the present day as the result of forces which we see actually in operation. Pushing back our inquiries, we at last reach the point where the apparent cessation, or failure of evidence, of former terrestrial conditions such as now exist, requires us to consider the relation in which our planet stands to other bodies in celestial space; and, vast though the gulf be that separates us from these, science has been able to bridge it. By means of spectroscopic analysis, it has been established that the constituent elements of the sun and other heavenly bodies are substantially the same as those of the earth. The examination of the meteorites which have fallen on the earth from the interplanetary spaces, shows that they contain nothing foreign to the constituents of the earth. The inference seems legitimate, corroborated as it is by the manifest physical connection between the sun and the planetary bodies circulating

around it, that the whole solar system is formed of the same kinds of matter, and is subject to the same general physical laws. These conclusions further support the supposition that the earth and other planets have been formed by the aggregation of matter once diffused in space around the sun; that the first consequence of this aggregation was to develop intense heat in the consolidating masses; that the heat thus generated in the terrestrial sphere was subsequently lost by radiation; and that the surface at length cooled and became a solid crust, inclosing a nucleus of much higher temperature. The heat of the interior of the globe increases about 1° Fahr. for every fifty or sixty feet of depth below the surface. The surface appears to have now reached a temperature which is virtually fixed, the gain of heat from the sun being just compensated by the loss from radiation into surrounding space. As the exterior gradually cooled, contractions necessarily ensued, producing change of form and dimensions; and to these, acting in combination with gravity, are, no doubt, largely due the great irregularities of the earth's surface. The strains set up by these forces must have continued to cause movements for a vastly prolonged period, and are doubtless still in action. But the irregularities of the surface constitute only a small part of the effects of internal heat on the earth, and mineralogy is the branch of science to which reference must be made for a knowledge of the many simple and compound substances that have issued, under the operation of chemical forces, from the vast laboratory contained within the cooling crust of the once incandescent globe.

During the passage of the globe to its present state many wonderful changes must have taken place. The ocean, after its condensation from a gaseous state into that of liquid, must have long continued in a state of ebullition, or bordering on it, surrounded by an atmosphere densely charged with watery vapor. Apart, however, from the movements in the solid crust of the earth caused by its gradual cooling and contraction, its early higher temperature hardly enters directly into any of the considerations that arise in connection with its present climate; and it must remain doubtful how long and to what extent those conditions of climate which interest us most, as having occurred during the period in which the existence of life is indicated, have been affected by such early higher temperature.

In the absence of any direct means of ascertaining the condition of the earth's interior, aid has been sought from mathematical science, by which it has been established that the thickness of the solid outer shell of the earth must be considerable; and that if the interior is in a fluid state at all, which is very doubful, it must be covered by a great thickness (probably not less than several hundred miles) of solid, comparatively unyield-

ing matter; and it is argued, with apparent force, that no passage can exist by which molten matter, if there be any, could ascend from such depths to the surface. Recent speculation has consequently suggested that even volcanic phenomena may be consequences of the heat developed by intense pressures set up by the mechanical forces concerned in the movements of the cooling outer solid crust, and that they are not immediate results of the very high temperature which almost certainly still subsists at great depths in the earth's interior. A more probable explanation would seem to be that by some local or partial removal of pressure in the otherwise solid interior, a portion of intensely heated matter is able to pass into the fluid state, and so finds a way through some fissure to the surface.

Should any still hesitate to believe that vast mountains like the Himalaya or the Andes, and analogous depressions of the bed of the ocean, can have been produced by a mere secular change of the earth's temperature, I would remind them that the forces called into action by the earth are proportionate to its magnitude, and that their effects must be on a corresponding scale. It has been calculated on sound data that the contraction of the diameter of the earth, consequent on the fall of temperature from a fluid state to its present condition, has been about one hundred and ninety miles. At this rate a subsidence of five miles, which is the approximate greatest depth of the ocean, would correspond to a fall of temperature of about 200° Fahr. But the elevations and depressions of the earth's surface were probably produced by a comparatively much smaller loss of heat, and were due rather to tangential strains than to direct up-thrust or subsidence. An illustration may assist in forming a proper estimate of the irregularities of the earth's surface, which, though apparently great, are insignificant when viewed in relation to its actual dimensions. This hall might contain a globe forty feet in diameter. If this globe represented the earth it would be on a scale of one foot to about 200 miles; and one inch would be equivalent to a distance of $16\frac{2}{3}$ miles, or 88,000 feet. On such a globe the difference between the polar and equatorial diameters would be less than one inch, and the greatest elevations in Britain would be about the thickness of a threepenny-bit. The highest mountains and the deepest seas would be shown by elevations and depressions of hardly more than one third of an inch; and if they were distributed as such features are on the earth, they would be visible only with difficulty, and to the unaided eyes of a casual observer would hardly interfere with the apparent perfect smoothness of the globe's surface.

The conception of the vast duration of geological time is one with which most persons are now more or less familiar. It is

well to remember that great though the changes in human affairs have been since the most remote epochs of which there are records in monument or history, nothing indicates that within this period there has occurred any appreciable modification of the main outlines of land and sea, or of the conditions of climate, or of the general characters of living creatures. The distance that separates us from those days is as nothing when compared to the remoteness of past geological ages. No numerical estimate on which reliance can be placed has yet been made of the duration even of that portion of geological time which is nearest to us; and we can say no more than that the earth's past history, as recorded in what we now find upon it, or as inferred from what we find, probably extends over hundreds of thousands or millions of years. It is through the facts of geography, as now acquired and interpreted, that the geologist is supplied with the means of arriving at the true signification of much that occurred in past time, the traces of which survive in physical features or organic forms. He finds that the most important agencies in determining and modifying the present conditions of existence on the earth, whether as affecting inorganic nature or organic beings, are closely connected with the actual distribution of land and sea, and the configuration of the surface; and he learns that it is through these agencies that he must seek to unravel the intricacies of the past.

The study of geology, in its turn, enables the geographer to understand many things that would otherwise be unintelligible to him. He thus learns how the boundaries of sea and land have been determined; where connections formerly existing have been severed; how islands have risen from the ocean and may be sinking below it; to what causes are due the rocky coasts and headlands, the indentations of the coasts, the formation of bays and fiords; at what time and by what means mountains have been raised up, plains laid out, valleys excavated, and the courses of rivers and positions of lakes fixed; and he is taught the constituents and qualities of the materials forming the surface of the earth, of the soil upon it, and of the minerals beneath it. And as a better insight is obtained into the natural relations of the mountains, the plains, the valleys, rivers, lakes, and seas, the conviction arises that the ever-diversified details of the face of the globe are in no sense accidents or fortuitous results, little worthy, as such, of admiration unless for their picturesque forms or wonderful proportions; but that they are the direct, orderly, and necessary outcome of the action of forces simple in themselves, and operating in accordance with well-known and invariable physical and mechanical laws. The perception of general characteristics of structure among the various features of the earth's surface that pass

under our review is, indeed, too often overshadowed and obscured by their magnitude, by the multitude of their details, and by the variety of their forms, which at first produce impressions of hopeless confusion; but, when once the idea of subordination to common laws is duly conceived, it receives confirmation at every fresh step taken.

The area of the dry land is very greatly exceeded by that which is covered with water. The whole surface of the earth being 197,000,000 square miles, about 55,000,000 are land and 142,000,000 water. The average height of the land above the sea-level is also very much less than the average depth of the sea-bottom below that level; so that a rearrangement of the surface is quite possible by which the whole of the land might be submerged with comparatively little disturbance of the present level of the sea, or reduction of its average depth. The highest measured peak of the Himalaya, known as Mount Everest, which is also the highest in the world accurately determined, just rises 29,000 feet above the sea-level, but such elevations even as 15,000 feet are, elsewhere, with the sole exception of parts of Thibet, confined to isolated peaks or very narrow bands along the crests of a few of the highest mountain-ranges. The area above 12,000 feet is about two per cent of the whole land, and that above 6,000 less than nine per cent. From a careful computation recently made, it would appear that the mean height of the surface of the land above the sea-level is about 2,250 feet; the continental areas having the following elevations: Europe, 939 feet; Asia, 3,073 feet; North America, 1,888 feet; South America, 2,078 feet; Australia, 805 feet. The greatest depths measured in the ocean exceed 27,000 feet, and it has been estimated that the mean depth is about 12,500 feet. About five per cent of the ocean area is less than 600 feet in depth, and a somewhat smaller proportion, more than 18,000 feet. About seventeen per cent is less than 3,000 feet. The ocean-bed generally appears to present very extensive, comparatively uniform plateaus, varied only by moderate undulations, possibly to be attributed to contractions of the earth's crust caused by cooling; these range in depth from 12,000 to 17,000 feet, and their general direction maintains a rough parallelism with that of the neighboring continents. Submarine deposits derived from the land do not extend beyond 300 or 400 miles from the shore; but at great depths deposits are being formed with extreme slowness, which are probably derived from decomposed organisms, or from cosmic, volcanic, or other matter, carried down through the water. Accepting these estimates, it will appear that the volume of land above the sea-level is about one fifteenth part only of the volume of the ocean.

With the latest additions made to our knowledge of the depth

of the ocean there has also been acquired an altogether new series of facts bearing on its temperature, and its capacity for supporting life. The variations of heat and cold, due to change of season or to day and night, which affect the surface, descend to a comparatively small depth, being greatly reduced in the first 100 fathoms, and below that depth for the most part eliminated, so that at 300 or 400 fathoms an approximately uniform temperature is met with. With increased temperature at the surface, there is increased evaporation, followed by greater density, by reason of which the surface water sinks, and the higher surface temperature is partially communicated to the subjacent strata. From the mobility of water, and its high specific heat, which is almost four times that of the materials composing the land-surface, the sea-surface can never acquire a very high temperature. At the same time, the evaporation which is constantly going on from the whole surface of the ocean leads to a large quantity of the heat it receives from the sun becoming latent, and powerfully aids in preventing an accumulatiou of heat. These facts render the ocean one of the most important factors of terrestrial existence; it furnishes to the atmosphere the moisture which is one of the essentials of life, and serves by the circulation of its waters, and the diffusion of vapor derived from it, to equalize the temperature of the globe, by moderating the extremes both of heat and cold. Hence the greater or less proximity of the sea directly affects all conditions of climate. The circulation of the waters of the ocean, which is set up chiefly by the action of winds on the surface, but in part by variations of temperature and of density, and by the effects of evaporation, is controlled in all its details by geographical features.

Among the influences which give to the earth the characteristics that most immediately affect its fitness for occupation by man and the support of life generally, those due to the atmosphere are, without doubt, the most prominent. These, under the designation of climate, are constantly affecting us. But of all recognized branches of science, that which treats of the atmosphere—meteorology—is at the present time certainly the most backward. The reasons are not far to seek. The air is invisible, and in its upper regions inaccessible. The changes it undergoes are difficult to observe, and, from their great complexity, difficult to grasp, while what we know of them is almost wholly confined to the immediate proximity of the earth. It is pretty certain that the most important among the causes which operate on the atmosphere are changes of temperature; but the application of mathematical reasoning to the movements of an elastic fluid such as the air, charged with watery vapor, when submitted to changes of temperature upon a rotating sphere, presents very serious difficulties,

and little has been done to grapple with them. What is known of these subjects is as yet almost exclusively empirical. Instrumental appliances are here far in advance of theories, and it is not to be disguised that great waste of labor too frequently results from an exaggerated refinement in observation, and subsequent numerical computation, which has no real value. The variations of the temperature, of the pressure, and of the motion of the air, and of the quantity of vapor it contains, give rise to the great series of phenomena which are included under the general term climate. Of these variations the primary causes are the action and reaction of the mechanical and chemical changes set up by the sun's heat as influenced by the earth's motion, terrestrial position, and the condition of its surface, as well as by fluctuations of the sun's heat itself, though of these last we know too little to do more than recognize their presence.

The conditions which determine at any place the greater or less degree and duration of direct exposure to solar radiation, and therefore the quantity of heat received there, are position in relation to latitude, combined with the diurnal and annual movements of the earth. The nature of the surface regulates the local accumulation of heat, by reason of the varying power of absorption or radiation possessed by different substances; while with elevation above the sea-level as the density of the air becomes less, the sensible temperature and the quantity of watery vapor are subject to corresponding change. The whole of the results thus produced, moreover, are modified by movements in the air consequent on atmospheric changes from place to place, or from time to time.

The inequalities of the earth's surface, which are insignificant when viewed in relation to the whole globe, are of the greatest importance in relation to the atmosphere. For, owing to the laws of elastic fluids, the great mass of the air and of the watery vapor it contains are concentrated very near the surface. One fourth of the air and one half of the vapor are found below 8,000 feet from the sea-level; one half of the air and nine tenths of the vapor are below 19,000 feet, which hardly exceeds the average elevation of the highest ranges of the Himalaya Mountains; while three fourths of the air and virtually the whole effective vapor lie below 30,000 feet, and therefore within the influence of the highest summits of those mountains. That portion of the atmosphere which is nearest the surface is manifestly the most likely to be acted upon by irregularities of relief, and by local variations in the power of absorbing or radiating heat or diffusing vapor. Hence it is certain that it is the movements of the lower strata of the atmosphere that chiefly affect all conditions of climate, though no doubt there are great movements in the upper regions to bring

about the restoration of equilibrium, which is being constantly disturbed from below. The principal periodical winds—such as the trade-winds, the monsoons, the land and sea breezes—are found to be essentially dependent on periodical variations of atmospheric pressure, accompanying variations of temperature due to geographical position or surface conditions. The proximate causes of the more characteristic winds have also been well made out. These, too, are due to atmospheric disturbances producing areas of high or low pressure; the rapidity and intensity of the development of which, with the direction of their paths and their position, determine the force of the wind, the direction in which it blows, and the manner in which it veers or backs, that is, changes its direction. But how the changes of pressure are determined, and what causes the transfer of the disturbed area, commonly under the form of an atmospheric eddy or vortex, in a definite direction, usually from west to east, is still to be ascertained; though here, too, it is obvious that the distribution of the land and sea areas, and of the ocean-currents, on which the temperature of the superincumbent air so immediately depends, combined with the rotatory motion of the earth, are among the principal agencies at work.

Among the most intricate problems of meteorology are those relating to the evaporation of water, the formation of vapor and its diffusion and suspension in the air, and its condensation as cloud, rain, or snow. The low specific gravity of aqueous vapor, and the consequent evaporation that releases it at the earth's surface, tend to diffuse it in accordance with the mechanical laws which govern elastic fluids. But the reduction of the temperature of the air in ascending above the surface renders this diffusion impossible beyond a certain point; and observation shows that the quantity of vapor actually existing in the upper parts of the atmosphere is mainly dependent on temperature, and amounts to not more than one fourth part of what would be present if it were diffused freely and simply obeyed the law of hydrostatic pressure. It follows that a height in the atmosphere is at length necessarily reached where condensation must take place and clouds or rains be formed, and that, speaking generally, the vapor in the upper strata of the air is constantly tending to a condition of unstable equilibrium, from which it may readily be once more restored to the earth in the shape of water. This sufficiently accounts for the rarity of a perfectly cloudless sky, which indeed can hardly exist excepting where such a movement of the air is going on as will carry off the aqueous vapor, as fast as it is formed by evaporation, to a region where the temperature is high enough to prevent its condensation.

The great activity of the air in discharging the functions of

equalizing temperature and distributing moisture over the earth is remarkable. If the whole quantity of moisture in the air at any moment were condensed so as to leave it absolutely dry, the resulting stratum of water if distributed evenly over the whole earth would be less than one inch in depth. Yet it is estimated (though perhaps on insufficient data) that the mean rainfall over the whole globe is not less than sixty inches in the year, and falls of ten times this amount are known to occur in some localities. Observations of the velocity of the wind at marine stations show that these results are due to the almost unceasing passage of air highly charged with vapor over the regions where and during the time in which rain thus falls, and to the unceasing renewal of the supply of moisture by evaporation. The relatively very large sea-area has an important effect in maintaining the supply of the rain that falls on the land; and the immediate dependence of rainfall on local geographical features is too well known to call for more than a passing remark.

A few words will indicate the magnitude of the forces which are called into silent and comparatively unobserved operation in the atmosphere by the sun's heat in the production and recondensation of aqueous vapor. It has, as I noticed, been estimated that on the average five feet of water falls annually as rain over the whole earth. Supposing that condensation takes place at an average height of 3,000 feet above the surface, the force of evaporation must be equivalent to a power capable of lifting five feet of water, over the whole surface of the globe, 3,000 feet during the year. This, not reckoning the force required for the transport of the rain in a horizontal direction, would involve lifting 322,000,000 pounds of water 3,000 feet in every minute, which would require about 300,000,000,000 horse-power constantly in operation. Of the huge energies thus exerted a very small part is transferred to the waters that run back through rivers to the sea, and a still smaller fraction is utilized by man in his water-mills; the remainder is dissipated in celestial space. A well-known consequence of the physical properties of the air is the gradual reduction of temperature observed in ascending mountains. This, amounting to 1° for about 300 feet of elevation, gradually produces a change of conditions similar to that caused by passing from the equator toward the poles, and at the greatest elevations an arctic climate is established even under a tropical sun. Among the sublimest sights furnished by nature are the great ranges of mountains which traverse or approach the tropics. Rising into the regions of perpetual snow, they discharge important functions in the economy of the globe. By the intrusion of the solid terrestrial surface into the upper part of the atmosphere, the low temperature there, which otherwise could have produced no effect on the

earth, is brought into active operation. Great rivers spring from the melting fields of snow and ice that crown the mountain-summits, and, swollen by the copious condensation of rain on their slopes, flow down to the plains below, which are fertilized by their perennial waters.

THE LAST STAGES IN THE GENEALOGY OF MAN.*

By M. PAUL TOPINARD.

OUR lectures hitherto have shown us that science has not yet succeeded in casting a clear light on the exact connections of the placental mammalia, and that it is still ignorant of the precise ways, direct or indirect, by which the present orders and families have been derived. Haeckel's genealogy has been the point of departure for numerous essays, which have rendered immense services; but, as the author himself declares, it is only a first sketch, and will have to be revised hereafter. It has been shown by our lectures that the present orders, families, and genera are the product of a long evolution and successive transformations, and did not exist when the first placental mammalia appeared, and when the first feebly determinative evolutionary movement of differentiation and reduplication of types, which led to existing forms, was manifested in the marsupials. It is also shown that the progressive passage from the marsupial fauna of that time to the existing fauna did not take place by a single series of species for each order, family, or genus, but in all the cases in which science is in possession of sufficient documents, by multiple series, anastomosing, intercrossing one another, and often constituting an inextricable network.

Here and there the advance seems to have been more direct, as in the ungulates, the carnivores, the cheiropteres, and the pinnipeds or aquatic carnivora, while in other orders, such as the insectivora and the rodents, it seems to have been in an exceedingly complicated way. That branch which, according to Haeckel, leads to man, is the one that interests us most. Let us consider, then, the station which succeeds that of the marsupials, the eighteenth from the moneres in Haeckel's genealogy, the lemurs.

The lemurs have been ranked among the quadrumana by Geoffroy Saint-Hilaire, Cuvier, De Blainville, Duvernoy and Milne-Edwards—that is, separated from man; and among the primates, or in the same order with man, by Linnæus, Lesson, Huxley, and Broca. Vogt and Haeckel call them prosimians, the Germans half-apes, and the French sometimes false apes. The dominant question in our investigation is, therefore, where they belong:

* From a lecture at the *École d'Anthropologie*, March 21, 1888.

should they be called prosimians, or should they figure among the primates?

The primates might be well defined by saying that they are placentary mammalia, non-aquatic—which excludes the cetaceans, sirens, and pinnipeds; without hoofs—which excludes the ungulates and proboscidians; having three kinds of teeth—which removes the rodents and edentata; and having molars neither with cutting blades nor with sharp, conical points—which excludes the carnivora and insectivora. They have no absolutely peculiar characters in common, naturalists not regarding the type of the cerebral circumvolutions. They have a discoidal placenta, and a uterus with a cavity not two-horned; the cheiroptera or bats have likewise the third characteristic. They have two pectoral mammæ; but so have the bats and the lamantins.

The teeth vary among them as to number, form, and permanence. They appear more specialized, brought nearer to one another, and more fixed in their general form, as we ascend toward man. There are four stages in the last category—the lemurs, the monkeys of the old continent, the monkeys of the new continent, and man.

The replacement of claws by nails forms one of the most important characteristics of the primates. Claws are designed and formed for attack and defense; the hoofs of the ungulates form hard soles for the feet, protecting them from contact with the ground and facilitating the march of the animal; while the nails are so shaped as to be adapted to the purpose of prehension. This adaptation is more or less perfect, and extends to more or fewer fingers among the primates, permitting another division into the perfect primates, like man and all the monkeys but one group, and imperfect primates. Another adaptive characteristic, the corollary of the nails, is the well-developed thumb, removed from the other fingers, and opposable to them. More completely than they, it also indicates an organ made to clasp, to seize. The primates may also be divided by this feature into three groups: Man, with whom the thumb is opposable only on the fore-limbs; the monkeys, with which it is opposable on all four of the limbs; and the imperfect primates, with which the adaptation is less exact or less marked on the hinder than on the fore limbs. Other characteristics, usually graduated in the ascending series of the primates, might be mentioned; but these are enough for our purpose.

To regard the primates in this way is a little to prejudge the solution we are seeking. From the instant we suppose a progressive development of characteristics in the series and divide the primates into superior, medium, and inferior, we are tempted to be indulgent in respect to characteristics which may be little accentuated or wanting in the last. From this, to assuming that

the lower primates are simply the beginning of the series, the transition from the other orders to that of the primates, is but a step. The lemurs furnish most of the imperfect primates of which we have spoken. They included or include three groups of animals—the *Galeopitheci*, the *Cheiromys*, and the lemurs proper.

The *Galeopitheci*, or flying-cats, inhabit the Sunda Islands, the Moluccas, and the Philippine Islands. They furnish one of the examples of the difficulty of placing in our classification certain groups qualified with paradoxical characteristics, for the reason that they are transitional groups having some right to be put in several.

The *Cheiromys* include only one genus, the aye-aye of Madagascar. It resembles the squirrel, but has features also of the ape and the lemur. By dentition it is an insectivore or lemur in infancy and a rodent in adult age. It is evidently a primate at the start, but a species hesitating whether it shall continue a primate or become a rodent.

The lemurs proper are divided into the fossil and the recent. The former appear in the Eocene when there existed parallel with them the marsupials in a declining stage and the first placental mammals—the carnivora, rodents, ungulates, and the insectivora. Europe has furnished five genera of them and America more, the most important among them being the *Anaptomorphus*, from which Mr. Cope makes man a direct derivative. The recent species are distributed in three geographical groups, the first and most numerous being confined to the island of Madagascar, the second to that island and Africa south of the Sahara, and the third living in the island of Ceylon, the Malacca Peninsula, the Moluccas, and the Philippines, or the regions which Haeckel supposes to constitute the remains of the vast southern continent which he calls lemurian.

The lemurs are tree-dwelling and nocturnal animals. They have four opposable thumbs with the exception of the tarsier, which has only the hind thumbs opposable. All their fingers, as a rule, have nails except the hind forefinger, which has a claw, or in the loris, the fore little finger; but the nails are all badly shaped and seem transitional from claws. A general formula can not be framed for the teeth. The number varies from thirty to thirty-six.

All these facts tend to establish that the lemurs have not a fixed, homogeneous type, but that they constitute a transitional group from animals with claws to animals with nails. They may consequently be regarded as the first or perhaps the second stage (regarding the *Cheiromys* as the first) toward the better characterized monkeys; but serious objections are brought against this view. One was based by M. Broca on certain features of the pla-

centa, indicating a violent separation in this important characteristic of the lemurs from the other primates. M. Vogt, while not attaching so great importance to this feature as M. Broca, brought other objections, based on diversities in the formation and connections of the jaw-bones, the structure of the orbits, the position of the os lacrymalis, the bare cerebellum of the lemurs, the shape of the uterus, the presence of inguinal mammæ in addition to the pectoral mammæ, and other points. Hence he concluded that there was no relation between the prosimians and the apes, and consequently none with man; and that, except the opposable thumbs, which occur also with the marsupials, the prosimians have no anatomical character in common with the monkeys. "Therefore it would be derogatory to all the principles of positive science to rank the prosimians among the probable ancestors of the human race." These objections are certainly important from the morphological point of view, but they do not oblige us to reject the lemurs from the order of primates. None of these divergent characteristics are contradictory of the idea that they are the first draught, the beginning, of the latter order. The characteristics drawn from the nails and the opposable thumbs press the others out of the view of the general idea which has directed the choice of the word primates.

The lemurs are the lowest family in the order of primates, and are further removed from the other families than the latter are from one another. The distance from the anthropoids to man is quite as great, as I have demonstrated in previous lectures, on the evidence of the volume of the brain and the cranial characters which proceed from it; and yet I class man among the primates. In strictness we might detach the lemurs and make a special order of them, the genealogical relation of which with the monkeys would not be thus prejudiced; but then we should be obliged to do the same with man. M. Vogt is, nevertheless, not consistent, and retains the word prosimians as the synonym of lemurs.

I have already insisted, in previous lectures, upon the relations of the lemurs with the marsupials, and more particularly with the phalangers. The insectivora come next in order. All authors, from Cuvier to M. Vogt, have mentioned the resemblance between the teeth of lemurs and those of insect-eaters. Their teeth, says Cuvier, arranging his orders downward, from man to the lower mammals, "begin to exhibit sharp tubercles gearing into one another as in the insectivora." "The Galegos," we find a little further on, "have the insectivorous teeth and regimen of the other lemurs. M. Vogt says that the dentition of the tarsiers is like that of the insectivora; and Prof. Huxley observes that the lobes of the molars are habitually very far in front, as in the insectivora. Gratiolet classed the lemurs with the insectivora. Deriva-

tion from the insectivora is, however, in no way contradictory with descent from the marsupials. The primitive type of the latter was insectivorous in the Triassic and Jurassic epochs.

The last relation to be considered is that with the ungulates, concerning which we have the observation of M. Albert Gaudry. "I have asked myself," he says, in his "Tertiary Fossils," "if the lemurs had not a community of origin with many of the extinct pachyderms." The resemblances between recent lemurs and the ungulates, pointed out by MM. Alphonse Milne-Edwards and Grandidier in their great work on Madagascar, lend credibility to this opinion. Two genera are conformed to the idea: *Adapis*, the Parisian species of which, derived from the gypsums of the Upper Eocene of Montmartre, was classed by Cuvier among the pachyderms, but appears, judging by the teeth, the skull, and parts of the limbs, to be only a lemur; and the *Aplelotherium*, classed by Gervais also with the pachyderms, and now recognized as a lemur. The resemblance occurs among the Eocene species of the stock of recent perissodactyli, such as the *Hyracotherium*, the *Lophiotherium*, and the *Pachynolophus*.

Mr. Cope has also discovered several species of Adapis in the United States, and confirms these resemblances. It is, however, proper to remark that the genealogy leading to man is not in question in this matter. Mr. Cope divides the American fossil lemurs into three families: the Anaptomorphs, which lead, by two branches, one to the monkeys and the other to man; the Mixodectines, the outcome of which I do not know; and the Adapides, which lead to the ungulates. The branch of the *Adapis* is, therefore, according to Mr. Cope, foreign to the branch leading to man.

We shall shortly now abandon the eighteenth stage, or the lemurs of Haeckel, to pass to the nineteenth, that of the catarrhinian apes, or rather to the monkeys as a whole.

The further I go, the more I am convinced that the anthropoids should be joined with the monkeys recognized by all under that name, and that they are only the highest family of them; and the more I am persuaded that they should be separated from man, looking at the matter from a morphological point of view, further than is admitted in a certain school; for the physiological or intellectual point of view is not for an instant discussable. The principal classifications of the primates are as follow:

Cuvier, two groups, man and the monkeys, the latter, under the name of quadrumana, being divided into apes, lemurs, and ouistitis, the first including what are called great apes or anthropoids.

Broca, in his last classification, which is only a variant of that of Linnæus—two groups: man and the anthropoids together; the monkeys, including those of the old continent or the pithecans, and those of the new continent or the cebians.

Huxley, in his last classification—three groups: man, the monkeys, and the lemurs, the monkeys being divided into the catarrhinians, platyrrhinians, and arctopithecans; and the catarrhinians subdivided into the anthropomorphous and the cynomorphous apes.

Vogt, in his "Mammalia"—first group, man, which we mention here, but which is not treated of; second group, the monkeys of the old continent, divided into anthropomorphous or tailless monkeys, and monkeys with tails; third group, the monkeys of the new continent, divided into platyrrhinians and arctopithecoids; and fourth group, the lemurs or prosimians.

From this we see that, with the exception of Broca, all these authors agree in uniting the great apes or anthropoids under the term apes, or catarrhinian apes, or apes of the old continent; and that Huxley and Vogt agree with Cuvier. Broca, too, may not be so isolated as I have represented him. We should recollect that he never formulated his division as above, but that it is the incontestable result of his teachings, and especially of those of his later years.

I have been led by my own studies, and resting on the differences that appear between man and the monkeys, great and small, drawn from the volume of the brain, the cranial characteristics which are the consequences of it, the facial traits that accompany it, and the characters of the skeleton which are developed in a parallel way—that is, from all the characteristics which I have especially studied—to abandon the classification of Linnæus and take up the one so much decried of Cuvier, against which no serious reproach has been brought except that of the use of the word quadrumanous and the narrow definition of the hand on which its rests. Cuvier may not have been much of a philosopher, but he was first among observers.

When Broca contested the application of the denomination quadrumanous to the monkeys to distinguish them from man, bimanous, he rested on the fact that the presence or absence of the thumb is not enough to authorize the names of hand and foot; that in man, every superior member concurs in the function of prehension, of which the extremity of the member is the immediate organ, while in the inferior member everything is organized with a view to the functions of locomotion and support which the extremity only seems destined to fulfill; in short, that there is a solidarity between all the parts of either limb, the various details of which constitute the characteristics of the functions of hand and foot. This is admirably true, as to man, at the summit of the evolutionary series of which he is the crowning. It ought to be true, too, when we descend the course of the series.

The fore-limbs of the monkeys are indeed adapted to the func-

tion of prehension, but they are at the same time organs of locomotion; the hinder limbs are also adapted to walking, but they are at the same time organs of prehension. With the lemurs there are also the same general types of all the limbs, for prehension in front, for walking behind, but the fore extremity is in fact more a paw, and the hinder one more a hand by comparison; witness, for example, the *Cheiromys.* Other monkeys are as quadrupedal as they are quadrumanous. Consider the three upper segments of each limb: there are indeed an arm in front and a leg behind; but look only at the last segment, and it will be found to be, in front as well as behind, a hand in its principal characteristics, the separated and opposable thumb, and the nails.

With man, the harmony is perfect, because the functions are specialized, and the organs are all adapted in the same respective directions, the fore ones for prehension, the hinder ones for walking. Beyond our branch of the primates, looking toward its origin, the four limbs all exhibit themselves with the same types, but less affirmed, less precise: all four for prehension, the fore ones more so; all four for walking, the hinder ones more so. The evolution begins after the train of the marsupials, and specializations are made in different directions. With some, as the galeopitheci and the cheiropters, the particular adaptation took the direction of flight; a part or all of the limb was not transformed, but bent itself to what was required, was obedient to solicitations. With others, as the ungulates, the adaptation took the direction of an exclusive locomotion upon all four limbs. These became gradually modeled upon the same type, the useless bones disappeared or were fused, and some superfluous motions ceased, while others became accentuated, and the necessary corresponding anatomical dispositions with them. With others, as the carnivora, which were to run on the ground to reach their prey, while they must be able at the same time to seize, hold, and tear it, the four paws remained perfect locomotor organs, but at the same time also organs of attack by their claws, and to a certain measure, particularly in the fore extremities, organs of prehension. An adaptation of another kind was produced with the monkeys. The animals from which they sprung dwelt in trees and ran along the branches. They needed to increase their power of prehension, they had to clasp the rounded trunks of trees, to hook on to branches in passing from one to another. The adaptation seems to have appeared first in the hinder limbs, and then in the fore-limbs. The whole of the limb did not have to lose its peculiar type for that; but it was enough if the extremities were in some way fitted to it. Nature was contented with nails, separated and opposable thumbs, and more flexible fingers, without going up to the next segment.

One fine day a revolution was effected. Just as an adaptation to arboreal life was produced at the expense of anterior species, an adaptation to terrestrial life was made, with a bipedal attitude favorable to a more extended vision, a diminution of the olfactory sense and of the facial prominence, a more perfect touch, and intelligence. Henceforth, all the living forces of adaptation tended toward the same end; the hind-thumb ceased to be opposable, the other toes diminished in length; what the feet lost the hands gained, and man was created, exclusively bimanous in front, exclusively bipedal behind, and all the accessory parts in the segments of the limbs confirming themselves in the types, less accented till now, which they had presented since the marsupials.

The peculiarity set forth by Cuvier of the opposable thumb perfectly characterizes what there is common and special among all the apes, the faculty of clinging to trees with the four extremities. It is true that this expresses only one of the details of that whole, perfect in man, which has given birth to the words hand and foot, but it is the essential one. It can not, however, be denied that the second characteristic necessary to the function of prehension—great mobility in every direction of the segments of the limb—is not very greatly developed in the hind-limbs of monkeys. Cuvier had, then, a perfect right to call all the monkeys quadrumana, although they were at the same time quadrupedal, and to oppose them to man. I, then, put the anthropoids and ordinary monkeys together under the name of monkeys, and will not recoil from the synonym of quadrumana if the term monkey does not suffice me.

The monkeys are divided into two groups, those of the old continent, also called catarrhinians, because their nostril-partitions are narrow and their nostrils are open below the nose (from κατα, low, and ῥιν, nose); and those of the new continent, also called platyrrhinians, because their nostril-partitions are broad, and their nostrils open on the side (from πλατύς, flat). The monkeys of the new continent are predominantly tree-dwellers, and are divided into two families—the monkeys proper of this continent, and the arctopitheci. The former are in turn divided into the diurnal—the howlers, the ateli, the sajous, etc.; and the nocturnal, including the sagoins, sakis, nyctipitheci, and the saimiris.

The arctopitheci or hapales are a group apart among monkeys, including the interesting wistit and the tamarin. They are tree-dwellers like the former group, and nocturnal like the latter. They afford an example of the imperfection of our modes of classification. They are monkeys, American monkeys, in many of their relations; but they lack the single characteristic that distinguishes all the monkeys, including the lemurs, and have the dentition neither of the American monkeys nor of the monkeys of

the Old Continent. We have removed the galeopitheci from the lemurs on account of the absence of the first character. Must we also remove the arctopitheci from the monkeys? Let us look at their characteristics. When we take hold of their skull in such a way as to hide the lower part of the face, they look exactly like American monkeys. Like the American monkeys, they have a round head, flat face, lateral nostrils, no gluteal callosities, no pouches. But they have not opposable thumbs, either in the fore or hind limbs, and this deprives them of the single characteristic common to all the monkeys and false monkeys. Further, they have claws on all the fingers, except on the hind-thumbs, which alone have nails. They have thirty-two teeth, the same number as the monkeys of the Old Continent and man, but with a different formula—one little molar more and one large molar less. Further, their teeth have some insectivorous characters; the lower canine is small, the molars work a little into one another like those of insectivora, and some, the forward ones, have sharp, conical points. The lower incisors of some species are pointed. Cuvier hesitated to put them among the quadrumana. For our own part, we readily see in them a step toward the primates, a kind of American lemur, a transition from the insectivora to the monkeys of the New Continent.

Fossil monkeys have been found in America, and it is remarkable that they all have thirty-six teeth, and relate themselves to the types of that continent as if the platyrrhinians had always lived there. The highest among them is the *Laopithecus,* which can be compared to the anthropoids of the eastern continent. In short, we are introduced in America to a special series, constituted, from its origin to its end, thus: Some insectivora; arctopitheci; nocturnal monkeys, beginning with the saimiris; diurnal monkeys; *Laopithecus.* MM. Vogt, Schmidt, and Cope accept this insectivorous origin.

The monkeys of the old continent are less tree-dwelling than those of the new continent, and are all diurnal. Most of them have pouches and gluteal callosities. Their teeth are generally less omnivorous than those of man, and tend, especially by the canines, to the carnivorous type, and are also less continuous. They are divided into the great monkeys, tailless monkeys or anthropoids, and tailed monkeys, which are again divided into semnopitheci, cercopitheci, and cynocephaluses. The semnopitheci (from σεμνός, venerable) include the entellus, the sacred monkey of India, a prominent figure in the Aryan legends, and the colobus of Abyssinia and Guinea. The cercopitheci include the guenon, which is found only in Africa; the magot, which lives in Africa and as far north as the rock of Gibraltar; and the macacus, which occurs in India and Japan. The cynocephaluses are large monk-

eys with a dog's snout, of which numerous species inhabit the most of Africa.

The Old World monkeys are related on one side to the lemurs, and on the other side to the ungulates. The former relationship is clearly admitted by Prof. Haeckel and Mr. Cope. M. Haeckel's argument, which is based chiefly on the conformation of the placenta, does not carry a strong conviction. Mr. Cope's rests chiefly on the conformation of the teeth, and is more solid. Mr. Huxley does not say that the monkeys are descended from the lemurs, but his descriptions suggest it. M. Vogt, as we have seen, rejects this genealogy, as also does M. Schmidt. The relationship with the ungulates is admitted by M. Gaudry, and is a consequence of the one that he has determined between the lemurs and the ungulates. In general, the *Adapis* and the *Aplelotherium* establish the communication on the former side, the point of junction being at the Eocene origin of the perissodactylic branch of the ungulates. On the latter side we have only one genus still known, the *Oreopithecus* of Gervais, which in dentition resembles the *Chœropotamus*, a genus of the *Suidæ*, or the artiodactylic branch of the ungulates. In return, there are genera of the ungulates belonging to the same stock of the *Suidæ*, or one nearly allied to it, which have marked resemblances with the monkeys. These are the *Cebochœrus*, or hog-monkey, of Gervais, the *Acotherulum*, and the *Hyracotherium* of Owen. It is also to be remarked that in his general demonstration of the relation of the preceding species with the ungulates, M. Gaudry does not separate the lemurs from the monkeys, as if, from the paleontological point of view—that is, in the ancient species—the two were confounded.

Assuredly this is a very slight basis on which to found a derivation of the monkeys, and ultimately of man, from the ungulates. Yet the hypothesis has been heard; M. Vogt seems disposed to accept it, and M. Schmidt concludes a chapter in his book with the words: "The monkeys have had a very distinct double origin; the American branch had ancestors of insectivorous forms, and the Europo-Asiatic branch, including the anthropomorphs, ancestors with pachydermatous forms. We are thus near the question of the pachydermatic origin of our own primitive ancestors."

If this be so, the catarrhinian monkeys are dispossessed of their filiation with the lemurs. I confess I can not make up my mind to accept this idea. The lemurs are to me primates, quadrumana, the lowest of the order, and as such the ones which have all the chances of having engendered the others. The theory of the descent of man from the hog does not seduce me.

I am an anatomist and craniologist, and will allow no one to cast doubt on the importance which I attach to the smallest mor-

phological feature; but I ask, if over and above the details of the conformation of the teeth, fingers, and toes, the tarsus and carpus, above the characters that reflect the exact kind of alimentation, the precise method of locomotion, there is not something more general, answering to special habits, to more or less aërian, terrestrial, aquatic, diurnal, or nocturnal ways of life or abode, which impresses on the totality of the organism that general family resemblance which the naturalist recognizes outside of all those special modes of adaptation, which he studies with so much care to find in it a testimony, an expression, a formula in support of his thought and vision. A particular trait, a progressive variation of form, it is evident, reflects in general the elevated influence to which I allude. The teeth, the condyle of the jaw and its articular cavity, the temporal fosses, express quite exactly the regimen of the animal, and consequently some of its habits. The patagium, of which some traces have been observed among the petaurite marsupials, permits us to establish a series leading to the bats and passing by the galeopitheci. The genealogy of the perissodactyli, one of the most satisfactory that science has determined, rests essentially on a single character, the number and degree of atrophy of the fingers or toes.

But is the chosen form of character all? Has not nature different ways of reaching the same end, and can it not distribute its influence over the whole of the organism without making any of the characteristics particularly distinctive, and even while leaving present seemingly contradictory ones? The mouse is recognized everywhere by its attitude, its walk, its head, and its general shape, and still is found under different names among the aplacental and the placental orders, with the rodents and with the insectivora, terrestrial, half-aquatic, half-flying, and flying. The same is the case with the genus squirrel, which is scattered, with changed names, among several orders, being simply modified in some peculiarity. There is a group of most remarkable leaping animals among the marsupials, which, while preserving its type, is distributed, according as it acquires certain new characters, among various placental orders.

I ask, then, if the peculiar bearings of the monkeys, if their habitat, exclusively in trees among their most pronounced representatives, which impresses a special stamp on the whole individual; if the proportions of their body, the extent and situation of the articular surfaces and the consequent mobility of the segments upon one another, do not furnish a sufficient motive for establishing their relationship with the lemurs, and not with the ungulates? Likewise the lemurs, which lead a similar life, conduct to the marsupials, which also constantly inhabit trees. Between the ungulates and the monkeys I see nothing common of

the same kind. I can not imagine an animal with hoofs, walking only on the ends of its toes, having metatarsi joined, lengthened, and raised up, with the four limbs brought close to the body, and moving nearly always in the same parallel plane—that is, adapted to a terrestrial, measured, and rhythmical locomotion—giving birth to an animal with nails, plantigrade, having movable fingers made to fit themselves around trees, to hook on to branches, with limbs endowed with the most unrestricted movements of abduction and adduction. But it requires no mental effort to conceive an adaptation already begun in this direction with the lemurs, and having only to continue and specialize itself still further in the monkeys.

BIRD COURTS OF JUSTICE.

SEVERAL writers have given descriptions of proceedings of assemblies of birds of various species which they regarded as formal "trials in court." While this view of the nature of the transactions noticed can not yet be accepted as established by competent observation, they are certainly of an interesting character, and reveal a peculiar phase of bird-life. Dr. Edmondson describes regular assemblies of crows of the hooded species—"crow-courts" they are called—which are held at certain intervals in the Shetland Isles. A particular hill or field suitable for the business is selected, but nothing is done till all are ready, and consequently the earlier comers have sometimes to wait for a day or two till the others arrive. When all have come, the court opens in a formal manner, and the presumed criminals are arraigned at the bar. A general croaking and clamor are raised by the assembly, and judgment is delivered, apparently, by the whole court. As soon as the sentence is given, the entire assemblage, "judges, barristers, ushers, audience and all, fall upon the two or three prisoners at the bar, and beat them till they kill them." As soon as the execution is over, the court breaks up, and all its members disperse quietly.

The Rev. Dr. J. Edmund Cox has given the particulars of a trial by rooks which he witnessed between fifty and sixty years ago. He was riding along a quiet road in the vicinity of Norwich, England, when he was startled by sounds of an extraordinary commotion among the inhabitants of an adjacent rookery. Securing his horse to a gate, he cautiously crawled for a hundred feet or so, to a gap in the hedge of a grass-field, to investigate proceedings. A trial by jury was seemingly going on. The criminal rook "at first appeared very perky and jaunty, although encircled by about forty or fifty of an evidently indignant sable fraternity, and as-

sailed by the incessantly vehement cawing of an outer ring, consisting of many hundreds, each and all showing even greater indignation than was manifested by the more select number." Even the scouts, although hovering about in all directions, were so deeply absorbed in the proceedings that they failed to notice their uninvited spectator. After a short time, the manner of the accused was seen suddenly and completely to change: his head bowed, his wings drooped, and he cawed faintly, as if imploring mercy. The inner circle closed in upon him and pecked him to pieces in a few moments, leaving nothing but a mangled carcass. The whole assembly then set up a tremendous screaming and dispersed; some seeking the adjacent rookery, but the greater number flying away across the fields. It is commonly known that rooks are addicted to pilfering, and that if the robbery is detected the offender is punished. It has been noticed that young rooks will often pilfer twigs or other useful materials from the nests of their elders, with which to build their own domiciles quickly; and although they are too cunning to be caught in the act, only committing their thefts when both the owners of the nest are absent, the robbery seems always to get known. When the crime has been discovered and proved, eight or ten rooks are apparently deputed to act on behalf of the whole community; they proceed to the convicts' nest, and in a few moments scatter it to the winds.

An Alpine tourist relates that, during an excursion in the Swiss mountains, he accidentally came upon a small secluded glen, which was surrounded by trees, and became the unexpected witness of a singular spectacle. About sixty or seventy ravens were ranged in a ring round one of their fellows, evidently reputed a culprit, and, with much clatter of tongues and wings, were engaged in discussing his alleged delinquencies. At intervals they paused in their debate, in order to permit the accused to reply, which he did most vociferously and with intense energy; but all his expostulations were speedily drowned in a deafening chorus of dissent. Eventually, the court appears to have arrived at the unanimous conclusion that the felon had utterly failed to exculpate himself; and they suddenly flew at him from all sides, and tore him to pieces with their powerful beaks. Having executed their sentence, they speedily disappeared.

Sparrows also are said to hold judicial inquiry into the conduct of, and mete out punishment to, their fellow-sparrows, but without the formalities which the rooks seem to observe. When a misdeed has been brought home to any one of their community, a force of four or more sparrows is deputed to carry out the execution of the verdict. In their hurry to discharge the decree, they all tumble over one another with the greatest pugnacity,

uttering a violent clamor. The castigation is soon over, and "the unfortunate sufferer having endured the penalty," says Mr. G. Garratt, in his "Marvels of Instinct," "is as well received afterward by the community as if it had committed no transgression at all."

Mr. Garratt repeats the following story from Father Bougeant: "A sparrow, finding a nest that a martin had just built, possessed himself of it. The martin, seeing the usurper in her house, called for help to expel him. A thousand martins came full speed, and attacked the sparrow; but the latter being covered on every side, and presenting only his large beak at the entrance of the nest, was invulnerable, and made the boldest of them that dared approach him repent of their temerity. After a quarter of an hour's combat, all the martins disappeared. The sparrow thought he had got the better, and the spectators judged that the martins had abandoned their undertaking. Not in the least. They immediately returned to the charge; and each of them having procured a little of that tempered earth with which they make their nests, they all at once fell upon the sparrow, and inclosed him in the nest to perish there, though they could not drive him thence."

Another equally tragic story is recorded by the Rev. G. Gogerly in "The Pioneers," his narrative of the Bengal mission: "The flamingo," he remarks, "is common in the low, marshy lands of Bengal. My friend Mr. Lacroix—the well-known missionary—when once sailing in his boat up the Hooghly, went on shore. His attention was shortly directed to a large gathering of these peculiar-looking birds in a field some little distance off. Knowing their timid character, he approached as near as he could without being observed or exciting alarm; and, hiding himself behind a tree, noticed all their proceedings, which were of a most remarkable character. After a great deal of noisy clamor, they formed themselves into a circle, in the center of which one of their number was left standing alone. Again there was a considerable amount of screeching bird oratory, when suddenly all the birds flew on the unhappy solitary one and literally tore him to pieces." The conclusion to which Mr. Lacroix came to was, that one of these flamingos had committed an offense against the rules of their order, that he had been tried by a kind of court-martial, was found guilty, and had been adjudged, and met with, immediate punishment.

The following stories concerning storks seem to indicate that they have views concerning the purity of their race, and act upon them: Bishop Stanley relates that a French surgeon at Smyrna, being unable to procure a stork, on account of the great veneration entertained for them by the Turks, purloined all the eggs

from a stork's nest, and replaced them with hens' eggs. Ultimately, chickens were hatched, greatly to the surprise of the storks. The male stork speedily disappeared, and was not seen for two or three days, when he returned with a large number of other storks, who assembled in a circle in the town, without paying any attention to the numerous spectators their proceedings attracted. The female stork was brought into the midst of the circle, and, after some discussion, was attacked by the whole flock and torn to pieces. The assemblage then dispersed, and the nest was left tenantless.

A somewhat similar case has been cited by the same author as having occurred in the vicinity of Berlin. Two storks made their nest on one of the chimneys of a mansion; and the owner of the house inspecting it, found in it an egg, which he replaced by one belonging to a goose. The storks did not appear to notice the change until the egg was hatched, when the male bird rose from the nest, and, after flying around it several times with loud screams, disappeared. For some days the female bird continued to tend the changeling without interruption; but on the morning of the fourth the inmates of the house were disturbed by loud cries in a field fronting it. The noise proceeded from nearly five hundred storks standing in a compact body listening, apparently, to the harangue of a solitary bird about twenty yards off. When this bird had concluded its address, it retired, and another took its place and addressed the meeting in a similar manner. These proceedings were continued by a succession of birds until eleven in the forenoon, when the whole court arose simultaneously into the air, uttering dismal cries. All this time the female had remained in her nest, but in evident fear. When the meeting broke up, all the storks flew toward her, headed by one—supposed to be the offended husband—who struck her violently three or four times, knocking her out of the nest. The unfortunate stork made no effort to defend herself, and was speedily destroyed by the troop, who also annihilated the hapless gosling, and left not a fragment of the contaminated nest.

The Rev. F. O. Morris, in his anecdotes of "Animal Sagacity," cites the following instance of a case which ended less tragically: "Some hens' eggs," he says, "were placed in a stork's nest, and the others removed. The female, not aware of the change, sat patiently the appointed number of days, till the shells were broken and the young chickens made their appearance. No sooner were they seen by the old birds, than they testified their surprise by harsh notes and fierce looks; and, after a short pause, they jointly fell upon the unfortunate chickens and pecked them to pieces, as if conscious of the disgrace which might be supposed to attach to a dishonored nest."

A singular case of almost poetic justice among storks is noticed even in so old a work as Goldsmith's "Natural History," into which it was imported from Mrs. Starke's "Letters on Italy." "A wild stork," runs the tale, "was brought by a farmer in the neighborhood of Hamburg into his poultry-yard, to be the companion of a tame one he had long kept there; but the tame stork, disliking a rival, fell upon the poor stranger, and beat him so unmercifully that he was compelled to take wing, and escaped with difficulty. About four months afterward, however, the latter returned to the poultry-yard, in company with three other storks, who no sooner alighted, than they fell upon the tame stork and killed him."

SKETCH OF J. B. BOUSSINGAULT.

BOUSSINGAULT, says M. P. P. Dehérain, "by applying the rigorous processes of analytical chemistry to the study of agricultural questions, laid the foundations of a new science on solid ground. When he began, agricultural chemistry was still groping in infantile efforts. . . . At the end of his long life he was able to see the processes of investigation which he had devised employed everywhere; his ideas, tested by thousands of experiments, taught in all the schools; and agricultural science sure enough of itself to guide those who were practicing it and lead them to success." M. E. Tisserand says that "the influence of his labors and publications upon agriculture was immense, and that they were the real point of departure of the great scientific agricultural movement which has been executed during the last forty years." We find his life, as we review it, for one who was so great in works wholly of the laboratory and the farm, to have been unusually full of incident and adventure.

JEAN BAPTISTE JOSEPH DIEUDONNÉ BOUSSINGAULT was born in Paris, February 2, 1802, and died on the 11th of May, 1887. His father, a modest tradesman, sent him to the classical course of the Collége Louis le Grand, without any particular thought of directing him to science; but one of his comrades introduced him to the laboratory of Thénard at the Sorbonne, and he was strongly attracted toward chemistry. He became a frequent attendant at the scientific courses, and was accustomed to repeat at home the experiments with which he had been most struck. Classical studies no longer interesting him, he left the college and attached himself to the lecture-classes of Thénard, Biot, Gay-Lussac, and Cuvier. At eighteen years of age he entered the School of Mines at Saint-Etienne, whence he was graduated an engineer in 1822. He had already published in 1820 a memoir on platinum silicide,

which was marked by sagacity and precision, a work which he was destined to resume and complete fifty-six years afterward, without modifying his first conclusions.

In his twentieth year, and when he was full of ardor in the pursuit of science, and thirsting for the glory of conquering in new fields of investigation, and at the very time, it seems, when he was contemplating a journey to Asia, he received a proposition from an English company to go to South America, to recover some old mines that had been abandoned for many years and resume the working of them. A scheme had also been broached for founding at Bogotá a school of mines like that at Saint-Etienne; and as there were explorations to be made in the volcanic districts, and the observations and determinations that had been begun by Humboldt to be carried on, Boussingault accepted the mission with its tempting prospects of further scientific work. In preparation for it, he doubled his diligence at the Sorbonne and the Museum, took lessons from Arago in the management of instruments of observation, and obtained letters of introduction from Humboldt. He took passage in September, 1822, in an American brig of eighteen guns, which did not succeed in making the landing at Laguayra without having "a brush" with a Spanish frigate.

Boussingault found the country in the midst of the revolution against Spanish rule. Bolivar had united Venezuela and New Granada into the Republic of Colombia, and had propagated the insurrectionary movement into Peru. The circumstances were hardly favorable for the prosecution of the peaceful work he had marked out. He sought Bolivar in his camp, to consult with him concerning the course he should pursue. The interview was rudely interrupted by a fusillade; it was, however, only a picket-skirmish, and the Liberator, resuming the conversation, remarked: "You will observe, sir, that you have come to a country where the miner's pick is less used than the soldier's musket; it is easier for me to give you an officer's commission than an engineer's license." Boussingault accepted the office of lieutenant-colonel.

Boussingault spent ten years in South America, making use of every opportunity to study the grand phenomena in which that region is so rich, and reaped as the fruit of his sojourn an abundant harvest of observations in many departments of science. His work included numerous mineral analyses; the discovery of a new mineral, which he named, after one of his teachers, Gay-Lussite; analyses of the milk of the "cow-tree," of palm-wax, of guanos, and of the thermal waters of Venezuela; and the discovery in the province of Antioquia of a bed of platinum, a metal which had previously been known only as it was disseminated in sands. He often made his analyses of minerals on horseback, with the aid of a portable balance; he carried a Fortin barometer slung over his

shoulder, with which he estimated the height of mountains. His methods of investigation were sometimes extraordinarily ingenious. In taking the temperature, for instance, in the crater of Pasto, having found his thermometer inadequate, he let down some of the tin-foil wrappings of his chocolate-cakes. The tin was melted. The temperature was therefore higher than the melting-point of that metal, or more than 235° C. He then let down a pistol-ball, which was not melted. The temperature was thus found to be lower than the melting-point of lead, or less than 332° C., and was therefore somewhere between the two extremes. The guide who accompanied him on this adventure could not conceal his nervousness at hearing the subterranean roarings of the volcano, and, looking into the crater, asked, "What if it should burst out?" "Then we should be lost," replied Boussingault. The guide answered, calmed by the coolness of his superior, "That is what I think too." In 1831 he accomplished the ascent of Chimborazo, which Humboldt had been obliged to give up, with the loss of one of his instruments—and recovered the instrument. Boussingault had many stories of his adventures in the South American wilds, which he used to tell with much enjoyment, and which his friends found very entertaining. During his travels on the pampas he was attended by an Indian, who cared for him as if he had been a child. He having been attacked by a violent fever, the Indian saved his life by himself chewing the proper food for his helpless patient and putting it into his mouth. On these plains Boussingault made his investigations of curare and other poisons, and of the properties of coca. He witnessed a number of earthquakes. On one such occasion he was obliged to drag out by the feet some unfortunate persons, who had prostrated themselves in front of a church in prayer, to save them from being crushed by the falling building. The stupefied natives made loud confessions of their sins, concerning which the chemist used to remark, when telling of them in after-years, that he heard some most curious stories.

Boussingault returned to France in 1833, having gained a hhig scientific reputation. The numerous contributions which he had sent to the Academy, says M. Dehérain, had revealed in him a sagacious and intrepid observer, knowing how to see well, and endowed with a broad critical sense. He was immediately appointed Professor of Chemistry in the Scientific Faculty at Lyons, then made dean of the faculty in 1837, Thénard's successor at the Sorbonne, and afterward professor in the *Conservatoire des Arts et Métiers* in Paris—an office which he held titularly till the end of his life, while he retired from active work in it in 1875, and was succeeded by M. Schloesing.

M. Boussingault's career was diversified by a short period—

from 1848 to 1851—of political service, in which he represented the department of the Lower Rhine in the Constituent Assembly, and was nominated Councilor of State. He discharged the duties of these offices—which he had accepted from motives of patriotism alone—while, his political activity being regarded as merely temporary and for an emergency, his professorship at the Conservatory was kept open for him. Having bade a final good-by to politics in December, 1851, he used afterward to say, "There are few men of science who have succeeded in it, and science has always lost by it." But he always followed political events with a lively interest. Although his liberal and republican opinions were subjected to more than one blow from the events which were enacted in France, he did not consider it his duty to refuse the distinctions which were addressed to the man of science; and, while he held himself apart from the official world, he had occasion to give Napoleon III some good advice—which was not followed—concerning the expedition to Mexico. By his marriage, in 1833, with Mlle. Le Bel, an Alsacian heiress, M. Boussingault became joint proprietor, with his brother-in-law, of the fine estate of Bechelbronn, in the Lower Rhine. The cultivation of this farm afforded excellent opportunities for experiments on the applications of chemistry to agriculture, concerning which it also suggested many questions; and the skill which had been cultivated and so creditably employed among the volcanoes and in the pampas of South America, now found a more practical field for its exercise in the investigation of matters which touched the vital interests of the nation, and, individually, of a large proportion of its members. These investigations laid the foundation of the science of agricultural chemistry as it is studied and practiced to-day; and Boussingault's French friends claim, not without reason, that his Bechelbronn farm was the prototype of the farm at Rothamsted, in England, and furnished the model after which the German laboratories for agricultural investigation were planned.

M. Boussingault's greatest scientific work, that for which he was most famous, was connected with his experiments upon the value of food-rations and the influence of various chemical agents upon the growth of plants; and those to ascertain whence plants derive their constituent elements. When he began them very little was definitely known on these subjects; even the composition of hay was not correctly understood. It was not his privilege to carry these inquiries to a complete result; but he made the initiatory intelligent efforts toward solving them, set the work well afoot, and pointed out to those who are still seeking with accumulated skill and intelligence the way which they should pursue. "The processes," says M. Dehérain, "for the estimation of carbon, hydrogen, and nitrogen had been made effective; the methods

were still laborious, but sure; M. Boussingault employed them, and in a few years succeeded in, to a large extent, sketching the great work which is still being prosecuted, without in any way changing the programme which the masters had laid out nearly fifty years before. His robust good sense was not deceived. He saw how the problem could be approached with exact methods of elementary analysis. If he had tried at this time to follow in M. Chevreul's tracks and undertake the immediate analysis of agricultural products, he would have been foiled. The time had not come, and it is interesting to compare from this point of view his first experiments on germination with those which he executed forty years later, when the progress of organic chemistry had made accessible what was not within reach at the beginning." In his analysis of plant-foods and his studies of the origin of the nitrogen in herbivorous animals, the rigor of his methods was marked; his conclusions were reached slowly, not from one or a few experiments, but after a series of them. "One must know," he would say, "how to criticise himself; it is not till after he has exhausted all objections that he can estimate the value of them, and come to a conclusion." His labors were characterized rather by the clear and precise view of the end to be reached, abundance of observed facts, and lucidity of demonstration, than by ingenuity of methods. It was only rarely that he permitted himself to indulge in those bold and specious generalizations which are so pleasing to many and are so quickly forgotten; and before the end of his life he was cured of all disposition toward them. "Skepticism, even a little harsh in regard to the labors of others, had become habitual with him."

With such slow deliberation and painstaking care he pursued through more than thirty years, in his laboratory and upon his farm at Bechelbronn, his experiments on the composition of plants and their parts; of soils and manures; the effects of different soils and different manures, of no soil (or only sand or gravel) and no manure, of air as it exists and of air purified of all foreign elements, upon the growth of plants; varying the experiments in every conceivable way, year after year, testing them one by another, and comparing them one with another—all for the double purposes of learning whence plants derive their nitrogen, and what are the best kind and form of fertilizing material for each plant and for each kind and condition of soil. The first question is still not solved. On the other side, the investigations have contributed greatly to the improvement of agricultural methods and to the rewards of wise cultivation. The results of these studies are embodied in the "Rural Economy" and the "Agronomy," and in such papers in the journals of scientific societies as those on "The Estimation of Ammonia in Waters"; on "The Quantity of Am-

monia contained in the Rain, Snow, Dew, and Fog collected at Liebfrauenberg"; on "The Method of Estimation of Nitric Acid in Presence of Organic Matters"; on "The Quantity of Nitric Acid contained in Rain, Fog, and Dew"; on "The Influence of Vegetable Mold on the Nitrification of Organic Nitrogenous Matter used as Manure"; on the inquiry "Whether Nitrogen is emitted during the Decomposition of Carbonic Acid by Leaves"; on "The Relation between the Volume of Acid decomposed and that of Freed Oxygen"; and many others. "He verified," says M. Tissandier, "the fact, only half seen by his predecessors, that plants fix the carbon contained in the carbonic acid of the air; he also proved definitely that plants decompose water to appropriate its hydrogen to themselves. He determined that plants derive nitrogen from the soil, and that, according to Lavoisier, in the vegetable kingdom as in the laboratory, 'nothing is created, nothing lost.' What is put into the soil as manure appears again in the plant as the crop." "Undoubtedly," says M. Dehérain, "the services which he has rendered to agricultural science by demonstrating the intervention of combined nitrogen in animal or vegetable nutrition are immense. The estimation of the value of rations and of manures rests upon principles that he has laid down; but whatever admiration we may feel for this part of his work, however great may be its practical utility, M. Boussingault has left it unfinished, and has never pointed out how atmospheric nitrogen is drawn into the movement of life."

M. Boussingault's eldest daughter having been married to a son of Jacob Holtzer, proprietor of extensive iron-works on the Loire, his son-in-law built him a spacious laboratory at the shops. Having been driven from Alsace by the Franco-German War, he afterward spent a considerable part of the year at this place, where he made his studies upon iron and steel. M. Boussingault published a memoir on the extraction of oxygen from the atmosphere by means of baryta, and conducted an investigation, with M. Dumas, of the proportions in which the constituents of the atmosphere are mingled. His "Rural Economy" was published in 1844, and an English translation in 1845. Revised and enlarged, and embodying the fruit of years of additional experiments, it was given forth in a new form, in 1861–'64, as "Agronomie, Chimie Agricole, et Physiologie," in three volumes. M. Boussingault was made a grand officer of the Legion of Honor in 1876. He received the Thénard medal of the "Société d'Encouragement" in 1872, and the Copley medal of the Royal Society of England in 1878. These medals he kept very carefully, along with the more modest medal which Bolivar had given him on their parting, and of which he thought more than of either of the others, for it was associated with the bright days of the South American life of his youth.

CORRESPONDENCE.

WOMEN IN BUSINESS.

Editor Popular Science Monthly:

I NOTICE a communication, in your July number, from Mrs. L. D. Morgan, of Baltimore, and, as it is on a subject in which all women are more or less interested, I beg the kindness of space in your columns for a reply. Mrs. Morgan opens her letter with the assertion, referring to the Women's Parliament recently held in Washington, that "one point seems to have been clearly developed, viz., that women are no nearer the ballot-box than they were fifty years ago." Fifty years ago such a gathering of women from all parts of the world as was seen at the Women's Parliament would have been utterly impossible, and had such a state of things been predicted it would have been received with as much incredulity as a prediction of the electric light or the telephone. Not only does the fact that such a gathering is now possible demonstrate that women *are* nearer the ballot-box than they were fifty years ago, but there is another fact which Mrs. Morgan seems to have entirely overlooked or forgotten, which is that in some of the States and Territories women are not only nearer but have actually reached the ballot-box, and are voting on State and municipal questions.

In the next paragraph of her letter Mrs. Morgan says: "The ladies who are acting in behalf of their sex are decidedly hasty and incautious in demanding, without limitations, equal pay for equal work. At first sight, indeed, the proposition seems a fair one," etc. Wherein or how these ladies are hasty and incautious, or wherein or how the proposition differs in appearance at second sight from what it was at first, Mrs. Morgan fails to show. Men, competing with men, demand equal pay for equal work, and why the same demand can not logically be made by women competing with men I fail to see. A little further on Mrs. Morgan says: "That a woman can acquire the routine of almost any mercantile pursuit may be admitted beyond a doubt; in fact, the quickness of her mind and her rapid if superficial grasp of a subject will give her the advantage, in many branches, over her brother workers." I respectfully ask, What is the routine of mercantile pursuits? If there is any special part or division of mercantile pursuits to which the word routine can be applied to distinguish it from any other part or division, then Mrs. Morgan may be correct, and women may have business capacity superior to men; but, until that fact is established, I will adhere to my conviction, produced by a life of work with both business men and women, that women are in no respect superior to men.

Despite of this pathetic description of "life as it is—the rough, every-day work of the world, where weakness means failure, strength success, where sentiment counts for nothing, and money is the paramount object"—I think Mrs. Morgan's knowledge of business life and business men is rather fanciful and theoretical than real. Is there not a contradiction between her assertion here that sentiment counts for nothing, and the one made a little further on in the same paragraph that "no man, who is worthy of the name, can quite bring himself to treat a woman clerk as he would a man, even in this ungallant age"? What but sentiment should prevent him from treating a woman clerk as he would a man?—the sentiment that women are made to be protected by men, and he will protect his, and those who have no protector must go unprotected. Had Mrs. Morgan's experience of business men been real instead of fanciful and theoretical, she would have known that "the employer who has expressed his disapprobation or impatience, without much regard to his p's and q's, would be much more dismayed to find he had insulted a male than he would to find he had insulted a female, as the male would in all probability resent the insult with a blow, to be followed, where the employer is anything of a politician, by his adverse ballot at the next election, while the female would have no resort except in the employer's sentiment, which, as Mrs. Morgan truly says, "counts for nothing." To discuss this part of the question, however, is mere waste of words, as the vast majority of business men, being gentlemen (a fact of which Mrs. Morgan does not seem to be aware), pay the strictest regard to their p's and q's in expressing impatience or disapprobation either to men or women.

For fear of infringing too much on your space, I will notice only one other point which Mrs. Morgan makes, on what she terms the "transitory nature of woman's work." She makes the old and oft-repeated but never proved assertion that women never remain long in any one business, for the reason that they marry, after which they retire to strictly domestic life. We have no statistics on this subject that I know of, but my personal experience goes to disprove this view of the matter. Five years ago I obtained work in an establishment where at the time were employed, besides myself, and in the same room, six men, two boys, and five women. Of these six men and two boys only one man remains, their places having in some instances been filled by men who are also gone, and have been succeeded by

others: *where they were succeeded by women, those women are there yet.* Of the five women who were there then, three remain, one having quit on account of ill health, the other for what cause I do not know. What does this record show of the "transitory nature" of woman's work as compared with man's? Mrs. Morgan might pleasantly spend her leisure time in gathering statistics on this subject in her own city; it would probably give her subject for thought, and would beyond doubt dispel her illusion that "woman is an anomaly in a business office among business men," or show her that the anomaly occurs so often that it has grown to be the rule. Respectfully,

LUCY S. V. KING.

25 FIRST STREET, CHATTANOOGA, TENN.

POPULATION AND THE FOOD-SUPPLY.

Editor Popular Science Monthly:

IN Prof. Huxley's article, "The Struggle for Existence," he states the obvious fact that "so long as the natural man increases and multiplies without restraint, so long will peace and industry . . . necessitate a struggle for existence as sharp as any that ever went on under the *régime* of war." But this promptly suggests the important modification that all classes of men do not increase equally. "Punch's" humorous statistics a quarter of a century ago gave to the well-to-do quarters of the town an average of only half a baby to each house! More serious observation shows, from the yeast-plant up, a steadily diminishing rate of increase, pyramid-like, until the cap-stone is reached—an average human family consisting of five persons, the three children replacing the parents, with only one to spare. But the cap-stone itself diminishes to a point. The human race differs in fecundity—the worst nourished and most emotional being the most prolific, and the best fed and the best poised intellectually producing not enough to maintain their own numbers. The Dutch numbered about two millions. They created their country largely out of the ocean, and survived a mud avalanche of cruelty and brute force. In South Africa, Java, New York, and elsewhere, they have been a permanent force, as well as in science, literature, arts, and arms. But their numbers have not greatly increased. On the other hand, the natives of the south of Ireland have been decimated by famines and chronic insufficiency of food They have founded no distinctly Irish colonies anywhere, but contented themselves with adhering closely to Anglo-Saxon communities in all parts of the world, which contact they declare to be injurious to them. It is claimed that their numbers have increased in recent times from about six millions to thirty millions, more or less. Eminent men, like George Washington, leave few or no descendants. Napoleon, as the fruit of two marriages, had one child. Hardly any of the peerages in the House of Lords, consisting of some four hundred members, are more than two hundred years old, and if, as proposed, no new peerages should be created, the hereditary legislators would become extinct—the object aimed at by the proposal. The present tendency of civilization referred to by Huxley, to sacrifice the best to the worst perpetually, would seem at first sight to reduce the whole to a dead level of the worst possible. But further reflection shows the effect to be to raise the whole mass from the bottom. If the mass can be well fed, refined, and intelligent, Nature will no longer throw off such frightful numbers of rudimentary men, but will be as niggardly of human beings as she now is chary of perpetuating great intelligences. In this direction there is hope that the problem may be solved.

The possible food-supply is encouraging. The census of 1860 showed that the maize-crop of the Mississippi Valley, if turned into its equivalents of beef and bread, would feed sixty millions of people. The food-resources of the sea have hardly been touched. All the fish known to have been caught by man's device would not make one school of the most numerous kinds. The position of the human race in regard to the visible but unavailable food-supply resembles that of hungry young children surrounded by square miles of ripe, waving grain and countless herds of beef-cattle. S. H. MEAD.

EUSTIS, FLA.

THE EARNED DECREASE.

Editor Popular Science Monthly:

THE argument of Mr. Joel Benton, in his article in the June number of the "Monthly," on "Earned Decrease *vs.* Unearned Increment," seems to be in several places quite defective. It scarcely touches the weakest points of Mr. George's theory at all.

It is argued by Mr. Benton: "If society has a claim upon this profit" (the "unearned increment") "in the socialistic way, which George and his followers claim it has, then, to make the equities right and even, it ought to shoulder, without a whimper, the losses which have befallen the land-owners who have suffered from the 'earned decrease.'" Really, however, if the matter is looked at in the proper light, it seems that the "earned decrease" offers, so far as land in the economic sense is concerned, no complication at all. Suppose that society asserts its claim to all the land, and becomes the owner *de facto.* Then, as to subsequent gains or losses in land-values, it is plain that society must enjoy the one and suffer the other, for, wherever social aggregation should bring increased value to land, society, under the George plan, would experience the benefit through greater rents; and wherever social dispersion should lower the value of land, society would sustain the loss through decreased rents. As to pre-

vious gains or losses, there would be two cases to consider—one in which society gives compensation to private holders, and the other in which it reclaims the land by outright confiscation. In the first case it would plainly be unjust to ask society to assume the burden of any "earned decrease." Suppose, for example, that A and B each own land of which the maximum value has been one hundred dollars, and that when society, or the state, buys the land, A's is at its maximum, while B's has fallen to fifty dollars. Can B claim that he should receive as much as A because his (B's) land has once been worth as much as A's, when it is now worth to the buyer only half as much? But in the second case—where confiscation is the hypothesis—it would be clearly inconsistent in society to assume the loss of the "earned decrease." Using the same example as above, if A gets nothing, can B, whose land is worth fifty dollars less, claim that he ought to get fifty dollars because the said land has fallen that much in value? The truth is, that what Mr. Benton calls the "earned decrease" is in most cases only a reduction, according to its size, of the "unearned increment"; that the former is nearly always less than the latter, and serves only to cancel part of it. Sometimes, however, social fluctuations destroy values which have been produced by actually expended labor. This fact, it seems to me, Mr. Benton should have brought more prominently into view; it affords the best foundation for his argument.

The deduction drawn by Mr. Benton from the example which he gives to show how worthless land is in some parts of New England is a very peculiar one. He says: "A friend of mine bought a productive farm of one hundred and sixty acres in Massachusetts a few years ago, with a good house, barn, and other fixtures upon it—and he did not pay *the price that the barn alone cost*. . . . This means getting the land itself for *less than nothing*, which is on better terms than Henry George's creed calls for." Has it not occurred to Mr. Benton that his friend may have paid for the land, and got the barn and other improvements for nothing? "Surface improvements" may, and often do, become absolutely valueless; but it is hard to conceive, so long as they have not reached this condition, that the ground on which they are fixed should be worth nothing.

The statement that neither Mill nor Spencer has offered any solution of the problem of dealing with the "unearned increment" is scarcely justified by the facts. Mr. Benton should read Mill's "Principles of Political Economy" and Spencer's "Social Statics" a little more closely. In the former he may refer to Book V, Chapter II, section 5. As to the latter, I am sorry to say that I haven't the book at hand, and can not give him the exact reference, but if he will have the patience to search for it he will find that Spencer also has a plan.

GEORGE P. GARRISON.

AUSTIN, TEXAS, *July* 10, 1888.

EDITOR'S TABLE.

STATE EDUCATION IN ENGLAND.

WE ventured in our last number a few remarks on the unsatisfactory results, in this city, of the political management of education. Evidence is now forthcoming that in England the cause of popular education has been no better served by state interference than it has been in this country. A Royal Commission that was lately appointed to inquire into the condition of education in Great Britain has made its report, and in that report there occurs what we can only interpret as a distinct admission of the superiority of voluntary effort over state control in the sphere of education. The report is not in our possession, but the following quotation from it appears in an English newspaper: "If it were needful to strike a balance between the efficiency of the two systems of board and voluntary school management, the evidence would lead us to divide the honors. The system of management transacted outside the school is most vigorously conducted by the school board, dispensing the money of the rate-payers; but in the closer supervision of the school, and effective sympathy between managers and teachers, or managers and scholars, the commission pronounce in favor of the efficiency of voluntary management. In the combination of the advantages of both systems we look for progress in the future." We confess to being at a loss as to what, precisely, is meant by "the system of management transacted in-

side the school"; but it strikes us very forcibly that it must merely be a means to an end—that is to say, that it must be secondary and subsidiary to "the system of management transacted inside the school"; and if so, the conclusion is inevitable that, as regards this far more important matter, the private schools carry off the palm for efficiency. The admission is, to our mind, a very significant one. Government can do outside work, but not inside work. It can put up buildings, provide apparatus, organize a staff of superintendents and inspectors, and make a great show over examinations; but when it comes to the vital point of teaching it breaks down, or, at best, does the work inefficiently. When will people understand that government work is esentially "outside" work, and that, when they want inside work, they must do it themselves? Government has the taxing power, and can do whatever the command of money enables it to do; but, when more than this is wanted—when, for example, to quote the words of the Royal Commission, it is a matter of establishing an "effective sympathy between managers and teachers or managers and scholars"—state agency will not work.

It so happens that, almost simultaneously with the appearance of this report, a teacher of long standing and much experience, Mr. James Runciman, publishes in the "Contemporary Review" a most powerful arraignment of the whole system under which the board schools in England have been conducted since the passing of the Education Act in 1870. That act he pronounces to be "a failure, if we contrast the means expended with the total results obtained; in fact," he adds, "the powers of evil seem to be gaining force, if we study broad results." Speaking of his own career as a teacher, he says: "After bitter years of effort I saw that I was frittering away my life, and thus the gladdest day I have ever known was that on which I knew I should work under the useless pedantic code no more. Ninety-nine out of every hundred teachers in Great Britain would follow my example if they could, for there is no chance for a man or a woman to lead a *human* life, so long as the code governs them; and I say deliberately that our national millions of educational grant are mostly spent on keeping up a mischievous imposture which broods like a perpetual blight over education." "Roughly speaking," he says in a later part of the article, "we have spent fifty million pounds of money on teaching a generation how *not* to become good scholars, good workmen, good clerks, or good citizens, and we have performed that remarkable feat in order to satisfy the fantastic desires of a set of pedants whose judgment is scouted by every practical man." We quote only the conclusions arrived at and vigorously expressed by Mr. Runciman, because we have not space for the facts and illustrations by which he supports them; but all who turn to his article for themselves will see that he has not spoken without great and bitter cause.

The Royal Commission express the hope that it may be possible in the future to combine the special merits of state administration, consisting chiefly, as we have seen, in capacity for work "outside the school," with the strong points of voluntary effort. The hope is an amiable one, but we regard it as wholly illusory. The very life of education resides in the free competition of ideas, in private initiative, and in the feeling of individual responsibility. Education without these can be little more than a hollow mockery. It will be "outside" work in the worst sense; and, when we seek to gather from it those fruits of intelligence and morality which a system of national education might be supposed to yield, we shall find the tree smitten with a mysterious disease, and the half-formed fruit falling withered to the ground. "A mysterious disease," do we say? Yes, mys-

terious to those—and to-day they seem to be the multitude—who look to the Government and the Legislature for their salvation in all things; but not mysterious to those who believe that the heaping of functions on the state is the very canker-worm of liberty and progress.

THE CLEVELAND MEETING OF THE AMERICAN ASSOCIATION.

THE recent meeting of the American Association for the Advancement of Science at Cleveland appears to have been a very satisfactory one. Many circumstances seem to have contributed to its success. The weather was favorable. The members came prepared with papers which were, for the most part, either in their scientific character or their practical bearing, worthy of the name of the Association. And the place of meeting was happily chosen. It had been thirty-five years since the Association met before in Cleveland, and during the interval the city had enjoyed a tenfold growth and development, which, as President Staley pointed out in his welcoming address, was, to a large extent, owing to the advance of science and its applications in the arts and in manufactures. "It would be difficult," the speaker added, "to find a city in which a larger proportion of the inhabitants are interested, directly or indirectly, in pursuits which depend upon scientific methods and processes." The people showed, by their attendance upon the meetings, by their treatment of the members of the Association, and by the avidity with which they read the unusually full newspaper reports of the proceedings, that they appreciated and enjoyed the privilege of having such a body among them. In these points they set an example to some cities of much larger proportions and pretensions.

The wonderful achievements of science, as illustrated by the work of the Association, and the industrial development of Cleveland, were the theme of President Staley's welcoming address. The speaker happily illustrated these wonders by introducing the figure of a citizen of Cleveland, who, meeting in the East a Persian story-teller of the Arabian Nights pattern, should easily defeat him in a game of capping stories by simply relating what he saw actually going on every day in the factories and workshops of his native place. The same topic was touched upon from another direction in President Powell's opening address, in which he indicated the innumerable fields of research that were represented in the membership of the Association.

The address of retiring President Langley, which was made at the evening session of the first day, was probably suggested by his own researches, and bore upon the history of the doctrine of radiant energy; while the speaker could not prognosticate the future of this doctrine for any distance in advance, he suggested, as a problem awaiting more immediate solution, the relation between temperature and radiation. The vice-presidential addresses bore the usual relations of such papers to the special departments in which their several sections were concerned. Prof. Stone, in astronomy, discussed the confirmation which Newton's theory of gravitation had received from studies in that science. Prof. Michelson, in physics, described his experiments to devise a standard of measurement from light-waves. Prof. Monroe explained what light the investigation of chemical compounds casts upon the doctrine of evolution. Prof. Cook, in geology, insisted upon the indispensable importance of American geology to the completeness of the science, and to the construction of a systematic and adequate nomenclature. Prof. Riley, in biology, who seems to have been exceptionally happy in his audience, traced the progress and establishment of the doctrine of evolution. Dr. Abbott, in anthropology, reviewed

the evidences—largely of his own discovery—of the extreme antiquity of man in America. Prof. Smiley, in economical science, sharply criticised many modern ideas and practices in benevolence, which he described as too indiscriminate and contrary to nature. The papers in the several sections mostly illustrated the personal researches of their authors or bore upon matters of daily interest, and seem to have been peculiarly acceptable to the audiences who thronged the meetings. The Association is always happy, when it meets in the basin of the Great Lakes, in being upon a ground which is fruitful in lessons in geology, botany, and climatology, and which could of itself supply subjects for papers enough to engage the whole attention of the meeting. These subjects were well represented. Industrial or manual training was not forgotten in the Economic Section; in which also Prof. Atwater essayed to show that the increase of the human race is never destined to outrun the possibility of food-supply; and the impracticability of the Panama Canal was demonstrated for the æth time. In anthropology, attention was called to several antique American works the preservation of which has been secured, and to many others which ought to be taken care of; the affinities of the Aryan and other races were considered; and interest was expressed in the institution of an international language, for the purposes of which Volapük was regarded as inadequate. A report was presented by Prof. Mendenhall, from the committee on that subject, on the teaching of physics.

While the work of the meeting was nearly all of a high scientific character, it was also of such a nature or so performed as to be what the people wanted. All the vice-presidents, says one of the city papers, "were wise in placing, as far as possible, their views and theories on a plane not too scientifically lofty for the appreciative observation of those less learned than themselves." Another newspaper expression is to the effect that—

> One great fact has stood out prominently in all the work of the Association in this city, and that is the practical value of science. No matter what the subject discussed or how technical the treatment, the connection between theoretical science and applied science was plainly discernible, and should need no argument to convince an intelligent resident of Cleveland of the value of applied science, or its intimate connection with everybody's business or the general welfare.

Another lesson, which has also an important social bearing, may be drawn from the experience of the city papers. They were not afraid to give full reports of the papers read, covering from one to two pages of their daily issues, so that members of the Association said the papers of no other city had served it so well, except, *perhaps*, those of Boston. Of the results upon themselves of making the large sacrifices of space usually devoted to more sensational matter which this required, the "Plain-dealer" says:

> Those who have read the reports from day to day will admit that the space was well filled, and that the influence on our city can not but be good. Science has been brought to the doors of our people and carried by the papers into their homes, and those who hitherto paid it no attention have been compelled to take some interest in it. To the surprise of some of the—at first unwilling—readers, the topics discussed were found to concern themselves, and to be treated in an entertaining manner. Instead of skipping the proceedings in the next day's issue, they read them with increasing interest, and on the third day turned to them with as much eagerness as if the columns contained a bit of political news, a murder—or a base-ball game. The appetite grew by what it fed on, and each new paper was read with keener interest and better understanding. The effect on such readers—and they can be numbered by thousands—will be lasting. They will hereafter pay more attention to matters of scientific character, and will have a greater regard for scientists.

Are the people, are the newspapers, of Cleveland, wiser or more intelligent than those of any other city, except perhaps Boston? Or is the fact beginning

at last to appear, that those who read the newspapers and sustain them appreciate matter of solid worth, and will buy it and read it when it is offered to them?

LITERARY NOTICES.

THE ORIGIN OF FLORAL STRUCTURES THROUGH INSECT AND OTHER AGENCIES. By Rev. GEORGE HENSLOW, F. L. S. Illustrated. "International Scientific Series," Vol. LXIII. New York: D. Appleton & Co. Pp. 349. Price, $1.75.

THIS volume deals with one of the most interesting departments in the whole range of botanical science. It is, in fact, almost common ground for both the botanist and entomologist. The author accepts as a fundamental principle that environment furnishes the influence which induces plants to vary. A brief outline of the steps taken by various authorities along this line, from Geoffroy Saint-Hilaire in 1795, to Darwin of recent time and Herbert Spencer of to-day, is given in the preface.

Prof. Henslow early had his attention attracted to floral structures in their relation to insect visitors, and this volume is an elaborate treatise in which the object, in the author's own words, is to "endeavor to refer every part of the structure of flowers to some one or more definite causes arising from the environment taken in its widest sense." The early chapters deal with those elementary principles so essential to a full and accurate understanding of that which follows. Symmetry, or lack of it, is treated at length, and many causes are assigned for the disappearance of petals, stamens, etc., or their augmentation. Then follows a discussion of the principles of arrangement. The alternation of the floral whorls is, for example, considered due to their being composed of spirals "which are projected on to the same plane and so form verticils," and the position of stamens follows in consequence of the branching of fibro-vascular bundles. In some cases the sepaline bundles give rise to a whorl of stamens, and in others the petaline cord. Why this should be is not understood. Nutrition is the immediate cause, but why the nutrition should flow in one or the other direction remains obscure.

The irritation induced by insects is a potent cause of the flow of sap to certain parts, which encourages local growth and thereby brings about a union between parts of a whorl or between different whorls. Prof. Henslow's theory is therefore "that the forms and structures of flowers are the direct outcome of the responsive power of protoplasm to external stimuli." That hypertrophy results from irritation is well shown in many instances, but some persons may be slow in granting all that the author is free to ascribe to the theory. He, however, makes a strong argument, and brings forward a great array of facts. Other causes are, however, not overlooked, and hereditary influences is one of these. Irregularity in flowers is shown to be for the purpose of securing the pollination of the stigma. "All flowers, as we have them now, which are in perfect adaptation to insect agency, are the outcome of the resultant of all the forces, external and internal, which the insect has actually brought into play, or stimulated into action by visiting them for their honey or pollen." With this working theory the author is able to show good reasons for the development of flowers having a bilateral symmetry. The portions of a flower upon which insects alight have become large and strong by responding to the strain that insects have brought upon them. Subsequently hereditary influences have come into play, and now the enlarged part may be present before there is any necessity for it. At the same time compensatory degeneration goes on in other parts of the flower. In the tendency of irregular flowers to become regular under cultivation, the author recognizes negative evidence to his theory. Presuming that the irregularity was brought about by insects, the demand for irregularity under culture being wanting, the flowers revert to their ancient regular form. "Did we but know what the insects were, and how they have poised themselves upon the flower, and in what way their proboscides and tongues have irritated the different parts, one might be able to describe more accurately the whole process; but that such have been the cause and effect as above described, seems to me to be too probable a theory to be hastily discarded in the absence of a better one." The author frequently refers to such striking examples of quick response in tissues to insect irritation as are seen in the formation of galls, and he concludes that if the stimulus

were constant in any one part of a plant, in the course of time the respose would become hereditary. Thus the adhesive pads of certain creepers (*Ampelopsis*) form before the tendril has come in contact with the wall. A similar development is true of the aërial roots of ivy, etc.

Nectaries have developed according to the same theory—namely, insects having been attracted to the juicy parts, withdraw the liquid and cause a flow of secretion, and finally a gland results. This is not unlike the statement that the excellence of milch-cows is largely due to the stimulation produced upon the milk-glands by the hands of the milker. Floral nectaries are correlated with pollination, they being invariably so placed as to subserve cross-pollination by insects.

It is shown by a long list of examples that sensitiveness and irritability are common phenomena in plants, whether in protoplasm, movements of organs, or formation of tissues, and the theory in hand is but an application of a general principle to the development of a particular part of the flower. The existing floral structures have been evolved under the mechanical and physiological impulses due to insect agencies. The colors of flowers, with all the display of streaks, etc., as path-finders to the nectaries, accord with the theory. "Instead, therefore, of a flower having first painted a petal with a golden streak to invite the insect and to show it the right way of entering, the first insect visitors themselves induced the flower to do it, and so benefited the future comers." The author's discussion of heterostylism—i. e., the different lengths of styles and stamens in the same species—is of great interest, especially that portion which deals with the origin of this condition in flowers. He assumes a homomorphic form as the primitive type, and dimorphism has been effected by varying degrees of stimulus, through insects, being applied to stamens and pistils, so that one set of organs may have been raised while the other was lowered. The lengths finally became so fixed that the best adaptation for cross-fertilization is thereby secured. This view not only ascribes to insects the original cause of variation, but that of the final stability in the dimorphic or trimorphic type. In summing up the treatment of metamorphosis of flowers, both progressive and retrogressive, Prof. Henslow concludes that the vascular cord is the fundamental floral unit, and, as these cords are identical before differentiation, it is not beyond expectation that petals may arise in place of stamens or stamens take the ordinary position of pistils. The primary cause may be less apparent, but doubtless it is in accordance with the governing action of environment modified by heredity. The conclusion drawn upon the somewhat obscure subject of fertilization is, "not that self-fertilization is *per se* in any way injurious, but that flowers which are normally sterile by having become so highly differentiated through insect stimulation do not now spontaneously set seed, and self-fertilization is not so efficient as crossing." Prof. Henslow has endeavored to make "a good theory of variation," and gives a direct cause for structural forms. He claims that the use of the expression "natural selection" leaves the subject where it was before. "Instead, therefore, of using this term as the cause of anything and everything, I prefer to attribute effects to hypertrophy, atrophy, resistance to strains, responsive action to irritations, and so on." It is possible that "natural selection" may underlie all these, and be so understood by many. As to the origin of a flower, the author thinks that it is only necessary to assume a leaf-bud, some of the members of which have differentiated into floral organs of the simplest type, as seen in the gymnosperm. Insects frequently search for pollen only, and by piercing the juicy tissues of such primitive flowers would introduce a series of changes which in time result in conspicuous blossoms. Whether or not the theory is accepted in all its many bearings, it is certain that every botanist must feel under obligations to Prof. Henslow for the excellent volume he has prepared, for the great array of facts therein, and the clear, concise manner in which the theory has been presented from first to last.

INDUSTRIAL LIBERTY. By JOHN M. BONHAM. New York: G. P. Putnam's Sons. Pp. 414. Price, $1.75.

THE author of this essay has evidently thought long and well on his topic. He has sought to treat the subject of industrial liberty in a manner somewhat different from that in which it has usually been discussed; and, aiming to keep in view principles rather

than statistics, he has undertaken to make an analysis of the salient political and industrial evils of our time, and to measure by fundamental rules the departure, in some of our governmental and industrial methods, from those principles. Such a purpose, it may be observed, implies considerably more than a superficial view of the labor and other questions "of the day," and regard to measures more abiding than the usual makeshift expedients. Whoever reads the book may not agree with the author, but he will have taken in that which will promote thought. Industrial liberty is defined to consist "in the freedom of each individual citizen, guarded by such delegated authority contributed by each as is necessary to preserve this individual freedom equally to each; and this liberty includes the freedom of each individual citizen to contract, and the sanctity of contract." The subject of the treatise is the effect which the world's development in industry and in political ideas, the growth of great industrial concerns, and modern practice in legislation, have had and are having upon the working of this principle. Steam and mechanical inventions have worked a complete change in the conditions of industry. Has it been for good? Mr. Griffin in England, and Mr. Atkinson in America, answer from statistics that, so far as physical wants are concerned, it apparently has. But it is not the workman's absolute present condition, "so much as a comparison of that condition or a contrast of it with the conditions around him, that comes into question. In other words, it is the increased disparity which constitutes his ground for discontent. Indeed, it is easy to understand that the bettered physical condition of the laboring man may of itself be a reason for his discontent, when we consider that this better condition has brought with it a better discerning faculty, a better power for comparing and contrasting conditions, and an improved capacity for reasoning upon differences." Another potent factor of recent growth in determining the conditions of the present time is the industrial corporation, which, having become monarch of the chief fields of enterprise, has been made a trust for the benefit of those who manage it, at the expense of the public for whom it is in theory supposed to have been primarily instituted, and even of a considerable portion of its own constituency. The corporation has had saddled upon it, to prey upon the public and bind it, the new form of trust, which is denominated a "parasite," and comes accompanied by other parasites upon industrial liberty. The histories of the growth of the great railway monopolies and the trusts which they carry, and of the Standard Oil and the gas trusts, are related. The remedy for these evils may be sought in treating corporate managers as trustees for the public; but the obstacles in the way of reform are formidable. They are reviewed at length. The influence of protection—which is declared to be a theory and not a principle—is next considered, and found to be not good, but in violation of natural law and encouraging to "trusts." A paternal government is defined and condemned as one which "in any way erects or creates obstacles tending to interfere with the industrial incentives and equal political rights of the citizen, or which fails to prevent the creation of such obstacles, or to remove existing ones." Under this *dictum*, protection, permission of discriminations, the common-school system, legal-tender government obligations, priority of liens, and business enterprises, direct or indirect, by the government, are condemned; but supervision and control of the government's artificial creations—corporations—in matters affecting the rights of citizens; administrative acts for the whole people; regulation of the traffic in intoxicants and poisons, prevention of food adulterations, and other acts of police, are not paternal, but within the proper sphere of government. The author's views respecting the common-school system, being different from those generally prevailing, are dwelt upon at length. Paternalism is less prevalent in America, and we have a great advantage in the freedom with which land may be alienated; but in both England and America a great deal remains yet to be accomplished; and much is hoped for the man who will be the product of the next civilization.

THE CHEMICAL ANALYSIS OF IRON. By ANDREW A. BLAIR. Philadelphia: J. B. Lippincott Company. Pp. 282. Price, $4.

THIS work is intended to embrace all the methods of value to the iron analyst. It

opens with a fully illustrated description of the necessary apparatus, many of the special forms of which are the author's own invention; this is followed by directions for preparing the reagents. Methods are then given for determining all the elements likely to be found in pig-iron, bar-iron, or steel, also for slag and oxides, several processes usually being given for each substance. Under carbon, the determination of total carbon, graphitic carbon, and combined carbon, are described. Methods for the analysis of iron-ores follow, also for the analysis of limestone, clay, slags, fire-sands, coal, coke, and gases. Tables of chemical factors, percentages of P and P_2O_5 for each milligramme of $Mg_2P_2O_7$, of tension of aqueous vapor, and for reducing volumes of gases to the normal state, are appended. The volume is copiously illustrated, and its print is large and clear.

THE ARYAN RACE: ITS ORIGIN AND ITS ACHIEVEMENTS. By CHARLES MORRIS. Chicago: S. C. Griggs & Co. Pp. 347. Price, $1.50.

AN exhaustive treatment of the above subject would fill many thick volumes, but the purpose of the author of the present work has been rather to give a brief outline of the history of that race from which the most cultured and powerful nations of the modern world have sprung. Mr. Morris discusses the several theories as to where was the home of the Aryans, and in what order and by what routes the different divisions of the race streamed out over Europe and Asia. He then gives a sketch of their customs and religion in their ancient home, and traces the course of their political development and of the development of the Aryan languages. The Aryan literature, and some other Aryan characteristics, also receive attention. Mr. Morris assures us that "all the statements concerning questions of fact have been drawn from trustworthy authors." The style is popular, and the author hopes "that the work may prove of interest and value to those who simply desire a general knowledge of the subject, and may in some measure serve as a guide to those more ardent students who prefer to continue the study by the consultation of higher authorities."

THE PRESENT CONDITION OF ECONOMIC SCIENCE, AND THE DEMAND FOR A RADICAL CHANGE IN ITS METHODS AND AIMS. By EDWARD CLARK LUNT. New York: G. P. Putnam's Sons. Pp. 114. Price, 75 cents.

THE author assumes, that while the doctrines of political economy have at no period shared largely in the public confidence, lack of confidence has in recent times become increasingly prevalent. The disrepute is explained by reference to the many conceptions of the science that are afloat; the disputes of economists; the "dismal" aspect which discussions have been made to assume the "bias that has been given by personal interests to the discussions; and the mistakes that have been made." The English method is criticised and objected to as being too deductive, too absolute, overfond of competition, and too reliant upon the *laissez-faire*, or "let-alone." The "new school" is sketched on its positive side as making the use of history a leading feature; and the value of this feature, and the extent and qualifications under which it may be safely applied, are discussed. This school has a good title to novelty in merging economics in the general science of sociology; and makes an attempt to unite ethics with political economy, which is pronounced impracticable and perversive. Finally, the new school lacks the great essential of a reason for existing, and, "as for scientific method in economics, the time seems now to have arrived when discussion is uncalled for, and when the question may safely be left to settle itself."

A TEXT-BOOK OF BIOLOGY. By J. R. AINSWORTH DAVIS. Philadelphia: P. Blakiston, Son & Co. Pp. 462. Price, $4.

THE author of this work is Lecturer on Biology in the University College of Wales. The book is designed for the use both of students who are studying alone, and those who are working under guidance. It is "divided into two parts, a botanical and a zoölogical, each of which deals with a number of types morphologically and physiologically, then briefly draws out the points of comparison between them, and ends with an outline of classification." A bibliography, and a set of examination questions, most of which are reprinted from the London Uni-

versity calendars, are appended. There are also separate index-glossaries for the two parts of the book, though a single index would be more convenient. The text is illustrated by one hundred and fifty-eight figures. In the vegetable part, representatives of the fungi, algæ, mosses, and ferns are described. The Scotch fir is taken to represent the gymnosperms; but as the angiosperms show such a great variety in form and structure, a general outline of the group is given, the various points being illustrated by, for the most part, common examples, instead of describing two or three species as representatives of the group. The part devoted to animals occupies about twice the space of that devoted to plants. The vertebrates are represented by the frog, pigeon, and rabbit. While the book contains no directions for manipulation of specimens, the parts of each organism are fully described, and the numerous cuts are minutely lettered.

SYNOPTICAL FLORA OF NORTH AMERICA: THE GAMOPETALÆ. Vol. I, Part II, and Vol. II, Part I. By ASA GRAY, LL. D. Published by the Smithsonian Institution. New York: Ivison, Blakeman, Taylor & Co. Pp. 480 and 494.

THE two portions of the late Prof. Gray's monumental work which have been so far published are reissued in the present volume. These parts together comprise all the gamopetalous dicotyledons. Vol. II, Part I, first published in 1878, has been extended by a supplement of seventy pages, and a complete index of genera, species, etc. A few pages of the text have been recast, and various minor corrections have been made. To the other part, published in 1884, a supplement of eleven pages has been added, and its full index has been made anew. The completed division constitutes the middle half of the entire flora, the author's design being to prefix an account of the *Polypetalæ*, forming Part I of Vol. I, and to add a second part of Vol. II, dealing with the *Apetalæ*, and Vol. III on the *Monocotyledons*. Vol. I would thus cover the ground of the two volumes of a "Flora of North America," published by Profs. Torrey and Gray in 1840 and 1843. Prof. Gray was occupied with his great work close up to the time of his death. All botanists will share the regret that he could not have been spared to bring the "Flora" to its completion, and will hope to see the remaining labor finally performed by hands familiar with the methods of the beloved master.

THE TARIFF HISTORY OF THE UNITED STATES: A SERIES OF ESSAYS. By F. W. TAUSSIG. New York: G. P. Putnam's Sons. Pp. 269. Price, $1.25.

THE papers comprised in this volume were written at different times and have been published through different channels; but they have been revised, pruned, and added to so as to form a harmonious whole, and as they now appear give a fairly connected history of tariff legislation and its workings from 1789 to 1887. The author admits that there may be conditions in the history of a country where a temporary qualified protective policy may be of advantage. Thus, "the transition from a purely agricultural state to a more diversified system of industry may be retarded, in the complete absence of other occupations than agriculture, beyond the time when it might advantageously take place. Secondly, when great improvements take place in some of the arts of production, it is possible that the new processes may be retained in the country in which they originate, and may fail to be applied in another country, through ignorance, the inertia of habit, and perhaps in consequence of restrictive legislation at the seat of the new methods. Here, again, the obstacles to the introduction of the new industry may be of that artificial kind which can be overcome most easily by artificial means." Yet, notwithstanding "both these sets of conditions seem to have been fulfilled in the United States at the beginning of the present century," the lesson drawn from the history of each of several leading branches of manufacture is, that protection has been of very little effect upon its growth. While cotton was probably assisted by the tariff of 1816, its manufacture was securely established before 1824, and "the further application of protection in that and the following years was needless, and, so far as it had any effect, harmful. . . . It appears that direct protective legislation had even less influence in promoting the introduction and early growth of the woolen than of the cotton manufacture." And it is concluded that

"the duties on iron during the generation after 1815 formed a heavy tax on consumers; that they impeded, so far as they went, the industrial development of the country; and that no compensatory benefits were obtained to offset these disadvantages." The history shows also that three different arguments have been urged at different times in favor of protection. First was the "young industries" argument, which began to lose strength shortly after 1832; next was the "home market" argument, to which the situation during the War of 1812 gave some vigor; and last was the argument based on the difference in wages in Europe and the United States, which, curiously, was first a free-trade weapon before the protectionists took it up. As a whole, "one does not find in the popular discussions of fifty years ago, more than in those of the present, precision of thought or expression." Through all tariff changes and discussions our manufactures kept on growing, as they would have done under any circumstances, Prof. Taussig seems to believe, by the sheer force of the nature of things. The history of the existing tariff is given with considerable fullness.

PTOMAINES AND LEUCOMAINES. By VICTOR C. VAUGHAN, Ph. D., M. D., and FREDERICK G. NOVY., M. S. Philadelphia: Lea Brothers & Co. Pp. 316. Price, $1.75.

TOXICOLOGY, the field in which the three domains of the chemist, the doctor, and the lawyer come together, has had its boundaries enlarged within the past ten years by the addition of the putrefactive and the physiological alkaloids. In this short period the activity of various investigators has brought to light a large number of facts concerning these substances. To collect, arrange, and systematize these discoveries, the reports of which were scattered through many journals, transactions, and other publications, has been the first object of the authors of this volume.

The work opens with a historical sketch of the subject, which is followed by a chapter of cases of poisoning by foods containing poisonous ptomaines. Poisoning by cheese and milk is treated with especial fullness, Prof. Vaughan being especially qualified to speak on this subject, since he is the discoverer of tyrotoxicon. The relation of ptomaines to disease is next taken up, and five theories which have been proposed in answer to the question, How do micro-organisms produce disease? are examined. The theory that the symptoms of infectious disease are caused by chemical poisons, ptomaines, which the bacilli produce by splitting up complex compounds in the body, is deemed by the authors practically demonstrated, and they cite the evidence for this theory as regards anthrax, cholera, tetanus, and other diseases. In the next chapter certain ptomaines which resemble in their reactions the vegetable alkaloids are described, and the danger of mistaking the former for the latter is pointed out. Several methods of extracting ptomaines are given, and the chemical descriptions of a large number of these substances follow. Similar descriptions of the leucomaines are given, and a twenty-page bibliography of the two classes of substances closes the volume.

Vol. IV, No. IV, of *Studies from the Biological Laboratory* of Johns Hopkins University (N. Murray, Baltimore, $1), opens with a short paper by Prof. W. K. Brooks, on "The Life-History of Epenthesis McCradyi," a species of hydro-medusa, illustrated with three plates. This is followed by "Observations on the Development of Cephalopods: Homology of the Germ-Layers," by S. Watase, with two plates. There are also two papers by F. Mall, M. D., one on "Development of the Ear of the Chick," with two plates, and the other on "The Branchial Clefts of the Dog, with Special Reference to the Origin of the Thymus Gland," with three plates. Mr. T. H. Morgan reports some "Experiments with Chitin Solvents."

The California Florist (Santa Barbara, Cal., $1 a year) is an illustrated monthly devoted to Pacific coast floriculture. It is popular and practical in character, and is edited with intelligence and good taste. The first number was that for May, 1888.

Mr. *Hubert Howe Bancroft* has prepared, and the History Company, San Francisco, publishes, uniform with the series of the "History of the Pacific States of North America," *California inter Pocula*, or "Cali-

fornia in her Cups"—a picture of what have been called the "flush times" of that State; or of its age of gold-hunting. The period and the scenes covered by the story were probably unique in the history of the world. Ordinary historical narrative can, as the author intimates, hardly do justice to them, because they were "so full of oddities, and crudities, and strange developments, consequent upon unprecedented conditions," that "to condense them into the more solid forms of history without to some extent stifling the life that is in them, and marring their originality and beauty, is not possible. There are topics and episodes and incidents which can not be vividly portrayed without a tolerably free use of words—I do not say a free use of the imagination." The record is therefore set off in a volume by itself, and given as an accompaniment to the history proper rather than as a part of it. The account begins with a description of the "Valley of California," its peculiar features and scenery. Then the review of "Three Centuries of Wild Talk about Gold in California," to which little value is attached as indicating any conception of the wealth which the country held, is followed by the story of the discovery of gold by Marshall, given in highly dramatic style and with the variant versions. The emigration from the East naturally follows, by its several routes, overland and by sea—giving opportunity to present vivid pictures of conditions that are past never to return. The circumstances which the emigrants found, or made, when they reached the El Dorado, are next in logical order, and are portrayed to a large extent in lively anecdote. These conditions include society in San Francisco and at the mines; the anomalous condition in which the emigrants found themselves in the entire absence of the influences of home and woman; mining life and customs; the administration of justice; the prevalence of drinking, gambling, and dueling; and Chinese and Indian episodes. A full account of the Modoc campaign is given under the last-mentioned head.

Additional volumes in G. P. Putnam's Sons' series of "English History by Contemporary Writers" are *Simon de Montfort and his Cause*, selected and arranged by the Rev. *W. H. Hutton*, and *Strongbow's Conquest of Ireland*, by *Francis Pierrepont Barnard*. The former volume gives the story of one of the most important and exciting series of events in the history of England—including the close of the struggle between crown and barons—from the writings of Robert of Gloucester, Matthew Paris, William Rishanger, Thomas of Wykes, and other chroniclers. The second volume deals with the first contact between the newly organized feudalism of Anglo-Roman England and the far older and more primitive civilization of the last independent Keltic states. It is made up of translations from a great many writers, all of the "olden time." Besides the interest and importance attached to the stories themselves, there is a peculiarly rare flavor about the books of this series, derived from the antiquity of the authors and the *naïve* style in which they wrote, so different in many of its features from modern composition.

The Historical American, "an illustrated monthly magazine of history, literature, science and art" (M. H. Meagher, Cleveland, $3 a year), issued its first number in July. Some of the chief articles of that issue are "Abraham Lincoln" (with portrait), by Henry C. Long; "Thomas Paine" (with portrait), by Colonel William Henry Burr; "True and False Civil-Service Reform," by Lester F. Ward; and "The Projects of Aaron Burr," by Charles H. Creighton. Under the heading "Notes and Comments" are printed Colonel R. G. Ingersoll's Decoration-day address, and extracts from an address by T. B. Wakeman, in defense of protection, before the Nineteenth Century Club of New York.

Stories of other Lands, compiled and arranged by the late *James Johonnot* (D. Appleton & Co.), is a reading-book of the historical series, designed for older pupils than those for whom the other volumes of the series were intended. It presents, in extracts from the works of standard authors, in prose and poetry, striking incidents in the histories of Spain, France, central Europe, and Great Britain, in the lives of artists, in the record of science and industry, and miscellaneous stories. The whole are designed and adapted to excite such an interest as will lead the pupil to more extensive read-

ing, particularly in the fields which are opened out by the selections.

C. N. Caspar, of Milwaukee, has announced a *Complete Volapük Dictionary; in Volapük-English and English-Volapük*, by *Klas August Linderfelt*. It is based on the last editions of the dictionaries of Schleyer and Kerckhoffs. Schleyer's dictionary is said to contain more than twenty thousand words, from which it will be seen that Volapük already has a considerable vocabulary. A new feature is added in the present work, in indicating the source and language from which each Volapük word is derived. From this it appears that more than sixty per cent of the radical words have their origin in the English language. Prof. Linderfelt's manual of Volapük has been very successful, three editions of four thousand copies each having already been published.

The ninth and tenth volumes of the *Bulletin of the Philosophical Society of Washington* (Smithsonian Institution, publisher), bound in one, contain the minutes of the society and of the Mathematical Section for 1886 and 1887, together with the proceedings of the Baird memorial meeting. A number of valuable papers are included in the *Transactions*. Among them are two presidential addresses: the first, by John S. Billings, at the December meeting of 1886, on "Scientific Men and their Duties"; and the second, by William Harkness, in 1887, on "The Progress of Science as exemplified in the Art of Weighing and Measuring." Another valuable paper is the discussion of the Charleston earthquake. The addresses at the Baird memorial meeting, by Messrs. Garrick Mallery, William B. Taylor, William H. Dall, and J. W. Powell, present incidents and estimates and illustrations of Prof. Baird's character from several points of view.

The Woman's Temperance Publication Association, Chicago, publish, under the title of *Our Standard-Bearer*, the life sketches and speeches of General Clinton B. Fisk, Prohibition candidate for President, by the Rev. *John O. Foster*, with an introduction by *Frances E. Willard*. Although primarily designed for a campaign document, the work is something more, and contains a pleasing miscellany of "army stories" and a record of active participation in works of benevolence.

The seventh volume of the *Archivos do Museu Nacional* (Archives of the National Museum), of Rio Janeiro, is of particular interest to us, because it is all the work of American students and authors. It includes the results of the studies of the Cretaceous invertebrate fossils made in the course of the prosecution of the Brazilian geological survey, under the direction of Prof. C. F. Hartt, which fossils were carefully preserved by Mr. Orville A. Derby, as director of the Geological Section of the National Museum, and have been examined by Dr. Charles A. White, of Washington, whose report upon them and specific descriptions constitute the text of the work. Twenty-eight plates of illustrations accompany the letterpress.

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Yale University, Observatory of. Report for 1886–'87. Pp. 15.

POPULAR MISCELLANY.

The Value of Scientific Teaching.—The chief value of scientific study, in Sir James Paget's view, is not merely in teaching facts, but in teaching the methods by which facts and principles may be obtained. Four great truths are taught by scientific education: those of the power of observation; of accuracy; of the difficulty of getting a knowledge of real truth; and of methods by which we can pass from that which is proved to the thinking of that which is possible. How difficult it is really to observe, is proved by every scientific discovery that is made; for each such discovery rests upon the clear observation of facts that have been within the range of sight of many, but previously overlooked. Science is essentially founded on accurate observation and accurate record and arrangement; and these are made more feasible by cultivating the habit of recording the facts while they are in sight—as an artist secures a correct portrait by looking at the object time and again, and painting accurately each time what he has seen. Science ought to be as accurate as art. Scientific education has the very rare value of demonstrating the utility of the most careful investigation, and of repeated observation, test, and examination; and it may fairly claim—which is its common boast—that it engenders a love of truth. The name of Sir John Lubbock should be a sufficient answer to the belief that scientific pursuits are not compatible with ordinary business occupations. The habits induced by such occupations may even aid science, by discerning some practical utility at the end of certain lines of work, and thereby sharpening the interest with which they will be pursued.

Officers of the American Association.—The following are the officers of the American Association for the ensuing year: *President*—T. E. Mendenhall, of Terre Haute, Ind. *Vice-Presidents*—A. Mathematics and Astronomy, R. S. Woodward, of Washington, D. C.; B. Physics, H. S. Carhart, of Ann Arbor, Mich.; C. Chemistry, William L. Dudley, of Nashville, Tenn.; D. Mechanical Science and Engineering, Arthur Beardsley, of Swarthmore, Pa.; E. Geology and Geography, Charles A. White, of Washington; F. Biology, George L. Goodale, of Cambridge, Mass.; H. Anthropology, Garrick Mallery, of Washington; I. Economic Science and Statistics, Charles S. Hill, of Washington. *Permanent Secretary*—F. W. Putnam, of Cambridge, Mass. (office, Salem, Mass.)—Holds over. *General Secretary* — C. Leo Mees, of Terre Haute, Ind. *Secretary of the Council* — Frank Baker, of Washington. *Secretaries of the Sections*—A. Mathematics

and Astronomy, G. C. Comstock, of Madison, Wis.; B. Physics, E. L. Nichols, of Ithaca, N. Y.; C. Chemistry, Edward Hart, of Easton, Pa.; D. Mechanical Science and Engineering, James E. Denton, of Hoboken, N. J.; E. Geology and Geography, John C. Branner, of Little Rock, Ark.; F. Biology, Amos W. Butler, of Brookville, Ind.; H. Anthropology, W. M. Beauchamp, of Baldwinville, N. J.; I. Economic Science and Statistics, J. R. Dodge, of Washington, D. C. *Treasurer*—William Lilly, of Mauch Chunk, Pa. *Auditors*—Henry Wheatland, of Salem, Mass.; Thomas Meehan, of Germantown, Pa. The Secretary announced the selection of the following committees, and their election followed: *On Chemistry Teaching*—W. H. Seaman, William L. Dudley, W. H. Wiley, W. O. Atwater, and W. A. Noyes. *On Water Analysis*—G. C. Caldwell, J. W. Langley, J. A. Myers, W. P. Mason, R. B. Warder, and W. H. Seaman. *On Organization of a National Chemical Society*—A. B. Prescott, Alfred Springer, and Edward Hart. Dr. A. B. Prescott was appointed substitute for Dr. Scudder on the Committee on Indexing Chemical Literature. The next meeting was appointed to be held in Toronto, on the last Wednesday of August, 1889.

Metamorphosis of Caddis-Flies.—Mr. J. H. Comstock has had the opportunity of observing a caddis-fly—in his aquarium—leave the water and take its first flight. "It swam to the surface of the water repeatedly," he says, in the "American Naturalist," "using its long mesothoracic legs. When swimming, these legs were extended at right angles to the body, like a pair of oars. The insect was unable to crawl up the vertical side of the aquarium, and, after clinging to it for a short time, it would lose its hold and sink back to the bottom. After watching it for a time, I lifted it from the water by means of a stick. At this time its wings were in the form of pads, which were but little, if any, larger than the wing-pads of the pupa, as shown by the cast pupa-skin found floating on the water. The instant the creature was free from the water, its wings expanded to their full size, and immediately it flew away several feet. In my efforts to catch the insect, I found that it had perfect use of its wings, although they were so recently expanded. The time required for the insect to expand its wings and take its first flight was scarcely more than one second; it was certainly less than two. As these insects normally emerge from rapidly flowing streams which dart over rocks, it is evident that if much time were required for the wings to become fit for use—as is the case with most other insects—the wave succeeding that which swept them from the water would sweep them back again and destroy them."

Some Laws of Heredity.—In a course of anthropological lectures at the South Kensington Institution, Mr. Francis Galton laid down, as a measurement of the influence of heredity, that each child inherits, on an average, one fourth of the personal peculiarities of each parent; one sixteenth of those of each grandparent, etc.; and that, if the previous ancestry are left out of account, the influence of each parent is raised to one third. From these laws, schemes of children, grandchildren, nephews, etc., can be constructed, though the particular place of any individual in any such scheme can not be predicted. Family likenesses and family differences; the stability of type in a population; the silent transmision of ancestral characteristics, and blended and mutually exclusive heritage, were illustrated by the metaphor of vegetation on two islands spreading over adjacent islets. The lecturer spoke approvingly of the measures adopted to promote higher physical culture by the establishment of special departments at Amherst and Harvard Colleges, and of the attention paid to the subject elsewhere. The purpose of the lectures was to discuss the influences that tend to produce the aggregate of the most favorable conditions for healthy and happy existences.

Hispaniolan Smokers.—The aborigines of Hispaniola, or Hayti, had a powder, cohoba, the smoke of which they inhaled through their noses. It was probably a preparation of tobacco. Oviedo (1526) describes the smoking of it through the nose, thus: "The instrument with which they inhaled the smoke was a forked hollow tube about a palm in length, and of the thickness of a little finger, well polished, well made, all of one piece. They inhaled the smoke as long

as they could, in fact until they fell down drunk. Those who could not afford such tubes made use of reeds." These tubes or reeds, Oviedo says, were called tobacco. Benzoni gives the following account of cigar-smoking: "When these leaves are in season, they pick them, tie them up in bundles, and suspend them near their fireplace till they are very dry; and when they wish to use them they take a leaf of their grain (maize) and, putting one of the others into it, they roll them round tight together; then they set fire to one end, and putting the other end into the mouth, they draw their breath up through it; wherefore the smoke goes into the mouth, the throat, the head, and they retain it as long as they can, for they find a pleasure in it, and so much do they fill themselves with this cruel smoke that they lose their reason. And some there are who take so much of it, that they fall down as if they were dead, and remain the greater part of the day or night stupefied."

Stellar Atmospheres.—Orray T. Sherman, in studying the stellar spectra comprising bright lines, has observed that, while persistent in place, the bright line is not persistent in intensity. This peculiarity affords a distinction between bright-line light, bright-background space, and any accidental disturbance the spectrum light may suffer. Collating his own observations, particularly those which he applied to β Lyræ, with Lockyer's results in the study of the solar atmosphere, we may, he says, "picture to ourselves the condition of the stellar atmosphere and the action therein somewhat as follows: An outer layer of hydrogen positively electrified, an inner layer of oxygen negatively electrified, and between them a layer of carbon mingling on its edge with hydrogen. The electric spark passing through the mixture forms the hydrocarbon compound, whose molecular weight carries it into the oxygen region, when combustion ensues with the formation of carbonic acid and aqueous vapor, both of which, descending under the influence of their molecular weight, are again dissociated by internal heat, and return to their original positions. Under the insight which this result gives we have found the spectra of the nebulæ referable to low excitation hydrogen, the spectra of the bright-line stars referable to high excitation oxygen, and hydrogen of higher or lower excitation according as the central star is of high or low magnitude, and, as far as the accuracy of the observations permits, τ Coronæ, Nova Andromeda, Nova Cygni, and the star near χ Orionis, itself a variable, likewise referable to the same spectra similarly conditioned. There is also reason for thinking that a similar atmosphere in similar physical conditions lies between us and the sun, and it seems as if we might consider that from the faintest nebula to the most highly finished star we have but progressive stages of the phenomenon here presented."

Across Greenland.—Mr. M. Nansen is engaged in an attempt to cross Greenland from east to west, with the aid of the Norwegian *ski*, or snow-skates. The experience of past expeditions has shown that the most successful and farthest advances over the glacial tracts have been made by the scouts provided with these useful furnishings; and he hopes that with their aid a party accompanied by a sledge-load of provisions may cross the country in about a month. He confidently expects to find a snowless tract in the interior; and hopes, by the observations he will be able to take (only rough ones, of course), to add something to our climatological and meteorological knowledge. He will give special attention to the question of the *slam*, or dust deposit in the snow—which Nordenskiöld regards as cosmic, but he as telluric and derived from the snowless region—to the curious snow-plants, and to the fauna and flora, of which casual appearances near the sea-coast indicate that the country is probably not destitute. The party, consisting of Dr. Nansen and six companions, landed July 18th in lat. 65° 30′, or nearly two degrees south of the Arctic Circle, implying a journey of some three hundred miles across to the west coast. The two Laplanders, who accompanied Nordenskiöld in his second unsuccessful attempt to cross Greenland (in a higher latitude and from the west side), managed to advance eastward some hundred and forty miles, and attained a height of over five thousand five hundred feet, whence they got a view of what appeared to be an endless snow-field.

Hygienic Living. — Some independent opinions on health and disease are expressed in Dr. Allinson's book, "Hygienic Medicine." Our civilization is held to be the cause of many of our diseases; thus, the close confinement of our homes is chargeable for diseases of the breathing apparatus; the artificial warmth produced by fires, clothes, and hot foods and fluids is injurious. Many suffer from want of exercise, others from not keeping their skins clean. Reasoning from their structure, men should live on fruit, grain, and vegetable products, especially fruit; food and fluids should be taken lukewarm and not hot. All diseases being regarded as but one, with different names according to the locality where they manifest themselves, the author prescribes as the one remedy for all, hygienic living—consisting of proper food at proper intervals, pure air always, regular exercise, and clean skins. Drugs are good only to kill parasites on the skin or expel them from the intestines, and to produce anæsthesia during surgical operations and insensibility to unbearable pains; otherwise they do harm rather than good.

Profits of Forest Cultivation.—The history of forestry in India shows, according to the presentment of Mr. George Cadell, in "Macmillan's Magazine," how a revenue which, in the year 1886–'87, returned a surplus of 41,017,000 rupees, was built up, under systematic management, "from not only an entire absence of income, but from a rapidly diminishing capital." The means by which this gain was drawn in were, "restraining the destruction of the forests by the wood-merchants, who felled for the sake only of personal aggrandizement, . . . by guiding, without checking, the cutting of trees by the peasantry for their agricultural and building necessities," and by steering "an arduous course" between the necessity for restraining reckless waste, and the obligation for meeting legitimate demand. The returns of three years' forest administration in the canton of Vaud, Switzerland—1884, 1885, and 1886—show that the 24,500 acres of forest-land gave an average revenue of more than five shillings per acre. The French forest budget for 1886–'87 shows a surplus of 13,400,000 francs, or 5·25 francs per acre. The Prussian forests return a surplus of 23,900,000 marks, which is equivalent to a net income of 3·6 marks per acre. Lands in Great Britain are told of, the agricultural value of which is no more than twelve or fourteen shillings per acre, that bear larches which, when sold, realize from one shilling to one shilling and threepence for each cubic foot. A certain crop of Scotch fir seventy-five years old, standing on ground the annual value of which does not exceed ten shillings, is valued for transfer at £132 per acre. Generally, a crop of larch standing within reasonable distance of a railroad-station ought to be worth £50 or $250 an acre when fifty years of age. It should be remembered, too, that while ordinary agricultural operations exhaust the soil, trees enrich it.

Walloon Superstitions. — The Walloons of Belgium believe in all kinds of omens, including most of those which are common in other countries. Among their superstitions is one that to meet a priest, when about to undertake anything unusual, is a certain sign of failure, and puts a stop to further proceedings. Few will throw reeds into the fire, because they are of service to oxen; and an ox having been present at the Saviour's birth, it ought to be regarded as sacred. The bed of a dying person must be placed in such a position that the rafters can not run in a contrary direction to it; for, unless they are parallel, the agonies of death would inevitably be protracted. When linen is washed, the water is never said "to boil," but "to play"; otherwise, the clothes would be destroyed. Precious stones are supposed to possess virtues more valuable than their intrinsic worth. An aërolite is said to be unsurpassed as a means for discovering a thief. The metal must be ground to powder, then mixed with flour and made into bread, of which no genuine thief can swallow the smallest portion. On Easter-Sunday it was the custom to breakfast off of two eggs that had been laid on Good-Friday, in order to render the eater proof against fever. To abstain from meat after Lent was a cure for toothache. In taking a dead body to the church-yard, if they come to four cross-roads, the bearers put down the coffin, and all kneel to repeat a short prayer. The idea is

that those who have left the world are sure to return to it, and that, as there are four ways, the traveler might wander aimlessly about, not knowing in which direction his home lay; therefore his friends pray for him at one of the roads, so that he may choose the right path, and not be misled by evil spirits. The mock court of Coucou was held at Palleur every year in August, at the nearest inn, and then, by adjournment, on the bridge. All the henpecked husbands and those who possessed any peculiarity were summoned before it, when the most ridiculous pleadings were had, nonsensical questions were asked, and appeals on mooted points were made to strangers present. The accused were always found guilty, sentenced to pay a fine, which must be spent at the inn, and then put into a cart, which was backed to a suitable mud-hole or pool, where they were shot out. The proceedings ended with the trial and ducking of the last man married in the village.

Types of Cliffs.—Dr. Archibald Geikie, in his book on "The Scenery of Scotland viewed in Connection with its Physical Geography," describes how the configuration of the coast is affected by the action of the sea. This work is traced around the cliffs, and the overhanging rocks which skirt the coast of parts of Caithness and Orkney are consequences of the direction of the great joints which run at right angles to the dip of the beds, so that wherever the strata descend with their planes of bedding toward the sea, the cliffs overhang. The joints are often pierced, so that the sea penetrates inward. The encroachments of tidal waters are recorded all along the coast. There are three types of sea-cliff which owe their characters to the rock forming them. First, the crystalline schists and old gneiss, which form a range of precipices running northward on the west coast of Scotland to Cape Wrath; crumpled, folded, and irregularly jointed, it is strikingly rugged, full of deep recesses and tunnels, and buttresses which extend into the sea. A second type of cliff is formed by the Cambrian sandstones of the west coast. They rise a few miles to the east of Cape Wrath in vertical cliffs six hundred feet in height. The perpendicular joints separate masses from the main cliff, and everywhere present a red or brown tinge. A third form of cliff is produced by basalt, well seen on the west of Skye, where it rises in precipices reaching to one thousand feet above the sea. But owing to the varying durability of the basaltic rock, it weathers so as often to form steep descents, which characterize these ancient lava-streams.

Private Lunatic Asylums in Great Britain.—The fortieth report of the British Commissioners of Lunacy shows an increase both in the general number of insane patients and in the number of those confined in private asylums over the numbers reported in the previous year. The general increase is less and the increase in the number confined in private asylums is relatively still less than was the increase returned in the previous year over the year preceding it. The patronage of the private institutions seems to have been materially affected by the agitation that has been made respecting them. Medical men are averse to running the risk of being involved in actions, and decline to sign lunacy certificates. The friends of persons of unsound mind have learned to look upon the private asylums with distrust. The effect of some recent judicial decisions has been to permit many weak-minded but not dangerous persons, who would previously have been put under supervision, to go at large. But the commissioners profess to be satisfied that the impression that patients are unduly detained in these establishments is wholly unfounded, and say that the houses were generally conducted during the year to their satisfaction.

Bees as Weather Indicators.—Prof. Emmerig, of the Royal Seminary in Lauingen, Germany, recommends bees as the surest prognosticators of the weather for the day. These insects are usually among the most docile and good-humored of animals, and show no disposition to sting unless they are provoked. But, if a storm is impending, they become restless and irritable, and are dangerous to approach. Sometimes the barometers will give the most emphatic indications of a storm, while the bees will continue quiet. The storm may break somewhere else, but not where the bees have omitted to give warning of it, or, if it breaks there, it will be light.

Then the bees may predict a storm when the instruments indicate fair weather, and the bees will prove the truer prophets. Prof. Emmerig cites eight or nine incidents that have occurred under his own observation within three years, where the bees and the weather-glasses failed to agree as to what the day's weather should be, and the bees carried their point.

Capacity of Native Siberians.—N. Jadrinzen, who has recently published a book about Siberia, expresses in it favorable opinions respecting the capacity of the natives of that land to receive civilization and of their promise of talent. The Samoyeds, according to School-Inspector Abramov, are a quite capable people, and their children show themselves proficient in mathematics. The remarkable natural talents and wonderful vital energy of the Tunguses are set forth by Middendorff. The Yakuts have been distinguished from the olden time for their cleverness, and take readily to civilization. The Kirghis have furnished a considerable number of able men, and are distinguished for their strong wit and rich fancy. The Altaians are not less gifted in religious intuitions and mental faculties; and missionaries have given accounts of very intelligent persons among them. The Tilents and black Tartars show decided inclinations toward civilization and a settled life. The Sarts and Tartars are sharper traders than even the Russians. M. Jadrinzen hopes that the newly established University of Tomsk, as its activity and sphere of usefulness extend, will awaken these people out of the torpor and hopelessness into which they have fallen, to a new life of enterprise and advancing knowledge.

Running Amok.—One of the most curious and unaccountable manifestations of human aberrations is in the Malay custom of running "amok." It breaks out, apparently, under the impulse of a momentary passion, but appears to depend, in the Malay's mind, upon a kind of belief that the act is the proper thing to do. In other words it is a convention. An instance of the frenzy recently occurred at Singapore. A Malay hadji, a "personal conductor" of pilgrimages, received a message from Mecca announcing the death of his daughter. He instantly decided, to appearance, that it was not worth while under the circumstances for any one to live longer, and, drawing his creese, stabbed the owner of the house. A boy who was present ran away and bolted the door outside. The frenzied Malay escaped by the roof, went into another house, stabbed two women, returned to the street, killed a Chinaman, attacked some other persons, and was finally knocked down with a pole by a native policeman, after having wounded six persons and killed three in a very few minutes. He soon calmed down, and, when asked why he had acted thus, answered that he did not know. Mr. Frederick Boyle, in one of his books on savage life, describes his emotions when he saw amok coming upon a Malay servant who was in the woods with him, and the frantic passion stealing over his eyes, apparently without any occasion whatever.

The Matrix of the Diamond.—The rock—a porphyritic peridotite—in which the diamonds of South Africa are contained, has been microscopically examined by H. Carvill Lewis, and found to be one of the most basic rocks known, having a composition of equal parts of olivine and serpentine impregnated by calcite. In this structure and in some other points it presents some analogies with meteorites. It constitutes a new rock-type, for which the name Kimberlite is proposed. It probably occurs in several places in Europe, and is known in Elliott County, Ky., and at Syracuse, N. Y., in the United States, at both of which places it is eruptive and post-carboniferous, and similar in structure and composition to the Kimberly rock. In most other diamond localities, where the gems are found in diluvial gravels and conglomerates of secondary origin, the original matrix is hard to discover; but in Borneo, diamonds and platinum occur only in those rivers which drain a serpentine district, and in Timor Laut they also lie in serpentine districts. In New South Wales, serpentine occurs near each locality where there are diamonds, and the same is the case in the Urals. Diamonds have been found in the Carolinas, where peridotite occurs in great beds and serpentine is abundant. All the facts thus far collected indicate serpentine, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

The Dullness of Anglo-Saxon Cities.—Mr. Frederic Harrison has made a complaint that English cities all over the world—with which American cities are classed—are dull and unattractive. The brightness of the life — at least among the better-endowed classes — which is recorded of the ancient cities of Greece and Rome, is not to be found in them; and the exhilarating vitality of Continental cities is likewise absent from them. They are healthy and rich beyond comparison with all other places, except, perhaps, ancient Rome, of corresponding importance, but, according to the summary of Mr. Harrison's lecture, they are dull abodes, usually wanting in beauty, seldom adorned with really admirable public buildings, filled with homes that give no pleasure to the eye, and over a great part of their area squalid, monotonous, and dingy. There are few festivals, and little real civic common life; the best classes withdraw their interest and declare the cities intolerable; the masses, except in their personal security, derive but little benefit from the organizations amid which they live. Life for the majority is deprived of the pleasantness which attaches to life in the country, and gives no compensations except those which are derived from the presence of great numbers. Mr. Harrison thinks that the size of the great cities is a drawback to their pleasantness, and this may be, to some extent, true; but a more satisfactory way of accounting for the condition may probably be found in the spirit of speculation which seeks to make money out of everything, preferring it to enjoyment, and plants noisome factories, with steam-engines and vapors, and racket, as near to all large centers of population as it can get them.

Effects of Petroleum Emanations on Health.—The influence of petroleum emanations upon health have been investigated by M. Wiecyk in the Carpathian region, where the workmen have to breathe an atmosphere that is tainted with carbureted hydrogen, carbonic acid, ethylene, various hydrocarbons, carbonic oxide, and sulphureted hydrogen. Cases of asphyxia are not rare. The affections ordinarily incident to long-continued work are tinglings in the ears, dazzling, beating of the arteries of the head, syncopes, and hallucinations, usually of pleasant character. The first feeling on breathing the vapors is one of lightness in the breast and greater freedom in respiratory movements; but this is soon succeeded by palpitations and general weakness. Diseases of the chest, particularly tuberculosis and epidemic and infectious disorders, are rare; a consequence, probably, of the antiseptic qualities of the vapors.

Andaman Island Myths.—The Andaman-Islanders, according to Mr. J. A. Farrer, in the "Gentleman's Magazine," believe the rat, crow, fish, eagle, heron, jungle-fowl, shark, porpoise, and various other animals, to be transformed ancestors, and have a definite legend to account for the transformation in each case. A certain fish, armed with a row of poisonous barbs on its back, is a man who committed murder in a fit of jealousy; and a tree-lizard retains the very name by which the victim was known as a man. The first human being of all fell into a creek and was drowned, when he was transformed into a whale and became the father of cetaceans. He capsized and drowned his wife and grandchildren while they were in a boat looking for him, and she was transformed into a crab, and his grandchildren into iguanas.

The White Mountain of Manchuria.—Mr. H. E. M. James, of the Indian Civil Service, and two companions, have made a journey through the Chang-pei-shan Mountains of Manchuria, and visited the sources of the river Sungari, thus penetrating to a district which had not previously been reached by Europeans. At Maoerh-shan, on the Yaloo, they found their progress up the river barred by impracticable precipices, while the few colonists of the upper valley had to depend upon the river when frozen in winter for intercommunication. They, therefore, changed their course to the valley of another stream. The Pei-shan, or White Mountain, from which the region they visited derives its name, proved to be an extinct volcano, with a blue pellucid lake filling the bottom of the crater, and surmounted by a serrated circle of peaks rising about 650 feet above the surface of the water. The sides of the mountain, which are steep, are composed entirely

of disintegrated pumice-stone, to which the peak owes its conspicuously white aspect when seen from afar. It can be reached only during the summer months, for snow prevents access to it at other times. The lake, whose name signifies the Dragon Prince's Pool, is six or seven miles in circumference, and is believed by the hunters to be under the special protection of the god of the sea. The inner sides of the crater looking down upon it are very precipitous. From its northern end a small stream issues, which becomes the eastern or smaller branch of the Sungari, while the main or western branch owes its origin to several streams rising on the southeast face of the mountain, two of which flow out in handsome cataracts. From the number and character of the rivers that rise in the vicinity, the Pei-shan Mountain is shown to be the very core and center of the river system of Manchuria.

NOTES.

Wood-creosote oil is recommended by Captain W. H. Bixby, in the Forestry Department's "Report on the Relation of Railroads to Forests and Forestry," as possessing valuable antiseptic properties. It is an efficient poison to animal and vegetable life; it thoroughly repels moisture, and its tar acids possess the power of coagulating albuminous and other fermentable matter. It forms an excellent insecticide, and is one of the best possible oils for preserving lumber and piling. Painted upon wooden or metallic surfaces, it preserves them from wet and dry rot, rust, and the attacks of insects. Forced into wood by hydraulic pressure, it will fill all the pores, extending its coagulating and antiseptic effects to the very center of the block. It is distilled on a considerable scale, in North Carolina, from the wood of the Southern *Pinus palustris*.

From a comparison of specimens of chipped implements from different sources—of flint nodules from Abbeville and St. Acheul, France, and Milford Hill, England; of argillite from Trenton, New Jersey; of quartz from Little Falls, Minnesota; and of black chert from the Little Miami, Ohio—Prof. F. W. Putnam has expressed the conclusion that man, in this early period of his existence, had learned to fashion the best available material, be it flint, argillite, quartz, chert, or other rocks, into implements and weapons suitable to his requirements; and that his requirements were about the same on both sides of the Atlantic, with conditions of climate and environment nearly the same on both continents. This brings up for future investigations the question whether he was the same on both continents, and whether he has left descendants or has passed out of existence.

A philosophical definition of luck is given by an English writer as a capability of being incapable. "The first Rothschild was probably right, from his point of view, when he said that he never would employ an unlucky man. On the other hand, the lucky man is usually the man who fits his fortunes; who, whether apparently able or stupid, can do just what his especial circumstances require him to do. Very stupid men are often ready men, armed with a readiness as of dogs when they twist from under a cart-wheel unhurt. The 'fool who makes a fortune' is usually a man with just the foresight, or just the judgment or the intuitive perception of the way things are going—a faculty like long sight or keen hearing, and independent of intellectual power—requisite to make large profits quickly. In fact, the fortunate man is usually the man who, in consequence of some hidden quality in his nature, deserves fortune.

As to the profitableness of hard-wood timber-growing, Martin Conrad, a wagon-manufacturer, of Chicago, says that of the five principal kinds of timber used in his business, white oak takes eighty years to mature; shell-bark hickory, from thirty to fifty years; white ash, thirty years; tulip-tree, sixty or more years; and red or Norway pine, at least sixty years. An acre of timber artificially grown is worth five times as much as an acre of natural timber. One tree will grow to the rod, or 160 to the acre—say 110 after eighty years. At that time each tree will give 500 feet of lumber, or 55,000 feet to the acre, and that in Chicago would be worth now $14.50 per thousand.

The question whether the rainfall is increasing on the plains has been investigated by Mr. M. W. Harrington, who, for the purpose, has examined two series of observations representing the average conditions at the epochs of 1850 and 1880. They show an apparent increase of rainfall toward the plains.

It is a common mistake, according to an eminent authority on bees, Mr. Frank R. Cheshire, to suppose that an angry bee is certain to sting on alighting upon a human hand. On the contrary, she will always examine the skin very carefully first with her palpi. It may seem that she stings at once, and without care or reflection; but a bee can do a great deal in a very short space of time, in proof of which it may be mentioned that "she can flap her wings more than four hundred times per second, and that each flap involves the extension and contraction, through a nerve impulse, of the muscles employed in the wing-movements."

THE Linnæan Society celebrated its hundredth anniversary May 24th. A eulogy of Linnæus by Prof. Fries, of Upsala, was read by the president, William Carruthers. Sir Joseph Hooker spoke of the merits of Robert Brown, "the greatest botanist of the present century," and said that where others have advanced beyond the goal he reached, it has been by working on the foundations he laid, aided by modern appliances of optics and physics. Prof. Flower delivered an address on Charles Darwin; Prof. W. Thiselton Dyer spoke on George Bentham, "who had stood in the footsteps of Linnæus, and, though the descent was oblique, inherited the mantle of the master." A Linnæan gold medal was instituted, to be presented to a botanist and a zoölogist in alternate years, but on this occasion awarded in duplicate to Sir Richard Owen and Sir Joseph Hooker.

EXPERIMENTS by Dr. Russell, of London, show that city rain contains twice as much impurity as that collected in the suburbs; that is, if the city rain were diluted with a nearly equal bulk of water, we should have the rain of the suburbs. On the basis of Prof. Lodge's experiments in clearing a bell-jar full of smoke by a discharge of electricity, whereby the carbon is deposited, Sir Douglas Galton argues that rain may be induced by disturbing the electrical condition of the air with kites or balloons. If this fails, no remedy for London smoke is left except that of using gas instead of open stoves.

A NATURAL history of panaceas has been suggested, the outline of which might show "how they originate—generally abroad; how some one writes an account of them in English; how every one rushes into print to show that that author is not the only man to go to for treatment; how they are all described as 'the greatest triumph of the century,' and this the more certainly the smaller they are; how they are universally adopted"; and then, after many years, "how they are finally investigated, and are often found to contain nothing."

A DEFORMITY of the hand peculiar to glass-blowers is described by M. Poncet as "glass-blowers' cramp." It consists in a permanent and pronounced flexion of the fingers, particularly of the third and fourth fingers of the hand, which comes on after a short practice in glass-blowing, and increases progressively. The glass-blowers call it *main en crochet*, or *main fermée* (hand in hook, or shuthand). It is supposed to be induced by the close and continuous application of the hand to the tube with which the workman manipulates his "metal."

OBITUARY NOTES.

M. J. C. HOUZEAU, an eminent Belgian astronomer, formerly director of the observatory at Brussels, died early in July. He was one of the editors of "Ciel et Terre," of Brussels, one of the most valued of our foreign scientific exchanges. As a writer, while exact and thoroughly versed—and a leader, too—in science, he employed a popular style, which laymen could read with pleasure, and students with the feeling that they were learning.

M. HENRI DEBRAY, an eminent French chemist, died, July 19th, after a short illness. He was born at Amiens, in 1827, and became the assistant to Sainte-Claire Deville, and eventually the successor to his chair.

PHILIP HENRY GOSSE, F. R. S., an eminent English naturalist, died August 27th, in the seventy-ninth year of his age. He was born in England, but spent much of his youth in Newfoundland and Canada, traveled in the United States, studying our zoölogy and entomology, and sojourned for a considerable time in Alabama. He was author of the "Canadian Naturalist," "The Birds of Jamaica," an "Introduction to Zoölogy," "The Aquarium," "A Manual of Marine Zoölogy," "Life in the Lower, Intermediate, and Higher Forms," a "History of British Sea-Anemones and Corals," "Letters from Alabama on Natural History," "The Romance of Natural History," and several other volumes, with numerous memoirs.

PROF. RUDOLPH J. E. CLAUSIUS, the eminent German physicist, died August 25th, in the sixty-eighth year of his age. He was Professor of Physics in succession at Zurich, Wurzburg, and Bonn, but was most distinguished for his share in the development of the mechanical theory of heat.

PROF. L. J. BUDGE, an eminent German physiologist, for more than thirty years director of the Anatomical Institute at Greifswald, has recently died. He was author of a "Hand-Book of Physiology" and of a "Compendium of Physiology," which is the favorite "cram-book" of the German medical students.

THE death is announced of Dr. Johann Odstreil, an eminent mathematician and physicist of Vienna.

DR. SIGISMUND WROBLEWSKI, Professor of Experimental Physics at the University of Cracow, died in May, from the results of a lamp-explosion in his laboratory. He was born in 1838, studied at St. Petersburg and Strasburg, and was appointed to his professorship in Cracow in 1882. He acquired great fame through his experiments and those which he performed in connection with Prof. Olszewski in the liquefaction and solidification of gases.

THE death is announced, at Rochester, N. Y., of Seth Green, the eminent fish-culturist, at the age of seventy-one years.

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