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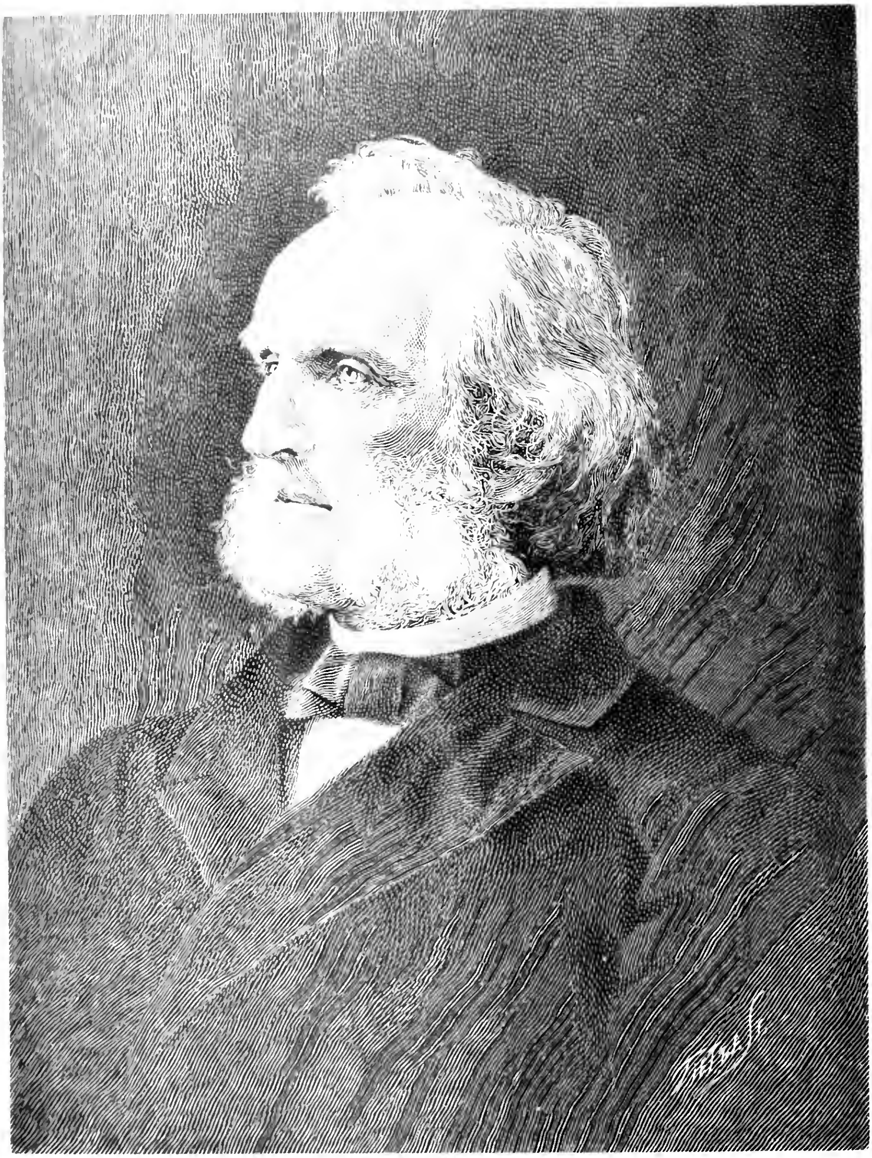

CHESTER S. LYMAN.

THE

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NOVEMBER, 1887.

THE ECONOMIC DISTURBANCES SINCE 1873.

By Hon. DAVID A. WELLS, LL. D., D. C. L.

V.

IN the preceding paper of this series (No. IV), evidence was submitted to the effect that the remarkable decline in prices which has occurred during the last ten or fifteen years—or since 1873—in the case of the various commodities which constitute the great bulk of the trade, commerce, and consumption of the world, has been so largely due to conditions affecting their supply and demand that, if any or all other causes whatever have contributed to such a result, the influence exerted has not been appreciable ; and, further, that if the prices of all other commodities, not included in such analysis, had confessedly been influenced by a scarcity of gold, the claims preferred by the advocates of the latter theory could not be fairly entitled to any more favorable verdict than that of "not proven." But have commodities, other than those whose production and price-experience have been submitted—more especially such commodities as have not in recent years experienced any marked change in their conditions of supply and demand—exhibited in their recent price-movements any evidence of having been subjected to any influences attributable to the scarcity of gold? The answer is, that not only can no results capable of any such generalization be affirmed, but no one commodity can even be named, in respect to which there is conclusive evidence that its price has been affected in recent years by influences directly or mainly attributable to any scarcity of gold for the purpose of effecting exchanges.

In the first place, all that large class of products or services, which are exclusively or largely the result of handicrafts ; which are not capable of rapid multiplication, or of increased economy in production, and which can not be made the subject of international competition, have exhibited no tendency to decline in price, but rather the reverse. A given amount of gold does not now buy more, but less, of domestic service and of manual and professional labor generally than formerly; does not buy more of amusements; not more of hand-woven lace, of cigars, and of flax, which are mainly the products of hand-labor; of cut-glass, of gloves, of pictures, or of precious stones. It buys notably less of hides and leather, which are the sequences of cattle-growing, which in turn involves time, and for which, in point of economy, large sections of the earth are not adapted; of horses, and most other animals; of pepper; of cocoa, the cheap production of which is limited to a few countries, and requires an interval of five years between the inception and maturing of a crop; of malt liquors, eggs, currants, and potatoes; and also of house-rents, which depend largely upon the price of land, and which in turn is influenced by fashion, population, trade, facilities for access, and the like.

How little of change in price has come to the commodities of countries of low or stagnant civilization, that have remained outside of the current of recent progress, is strikingly illustrated in the case of a not unimportant article of commerce, namely, the root *sarsaparilla;* which, with a gradually-increasing demand, continues to be produced (collected and prepared) in Central America, by the most primitive methods, and, without any change in the conditions of supply, save, possibly, some greater facilities for transportation from the localities of production to the ports of exportation. Thus, in the case of Honduras sarsaparilla, at New York, which is the principal distributing market of the world, the average price for the best grade is reported as identical for the years 1881 and 1886; while for the "Mexican," the average reported for 1881 was eight cents per pound, and for 1886, with much larger sales, from seven to eight and a quarter cents.

All the evidence, furthermore, tends to show that there has been very little decline in recent years in the prices of such of the commodities of India as constitute her staple exports, which can not, as will be hereafter shown, be clearly referred to agencies entirely disconnected with any influence assumed to have been occasioned by any increase in the purchasing power of gold due to its absolute or relative scarcity.*

Now, all of the commodities referred to, including labor and personal service, and many others which might be specified, whose condition in recent years has not been materially influenced by changes

* According to Mr. Robert Giffin, in his testimony before the British Commission, "On the Changes in the Relative Values of the Precious Metals," 1886, the general result of a comparison of India prices submitted to the Commission "On Trade Depression," shows a fall of only two per cent in 1880–'84, as compared with 1870–'74, or with the period immediately before the fall in silver:

"The general conclusion appears to me to be that the effect of the present relations between gold and silver have not told appreciably on prices in India, or on the relative progress of her import and export trade."—*Testimony of Sir* Louis Mallet, *late Under-Secretary of State for India, Trade Depression Commission,* 1886.

affecting their supply and demand, ought to have exhibited evidence, in a decline of prices, of the influence of the scarcity of gold, if any such had been exerted; but they not only do not, but the drift of the evidence deducible from their price-experiences is rather in favor of the position recently taken by some economists, that gold in recent years, in place of becoming scarce for purposes of exchange, has really been more abundant.

The record of extreme changes in prices by reason of circumstances that are acknowledged to have been purely exceptional, is also most instructive, and removes not a few commodities from the domain of any controverted economic theory respecting monetary influences. Thus, from 1862 to 1870, cotton, owing to war influences, ruled so high—from 70 to 800 per cent in excess of normal prices—that its inclusion in computations, with a view of determining any average of prices, or generalization of causes affecting prices during the years mentioned, would, without proper allowance, completely vitiate any conclusions.

War and interruption of traffic on the Upper Nile have increased the prices of "gum-Arabic," and of the drug "senna" in recent years more than 100 per cent. The prices for French and other competing light wines and brandies are much higher than the average for 1866–'67, because the phylloxera has so impaired the production of French vineyards that France now imports more wines than she exports. "Cochineal" and "madder" have greatly declined in price since 1873, because their use as dye-stuffs has been to a great extent superseded by equivalent and cheaper coloring-materials derived from coal-tar; and within a very recent period the discovery of a method of cheaply preparing a chemical preparation from cloves, having all the flavoring qualities of the vanilla-bean, has already diminished the demand, and bids fair to greatly impair the price of this heretofore scarce and costly tropical product. Certain animal products, notably entering into commerce, have rapidly advanced in price in recent years by reason of a rapid diminution in the number of the animals affording them, as buffalo-horns, ivory, and whalebone, which latter product has increased in price from 32½ cents per pound in 1850 to 85 cents in 1870, and $3.50 in 1886.

An agency which has been most influential in recent years, in occasioning a decline in the price of commodities, which has acted universally, which is entirely the outcome of new processes, construction, and machinery, and has no connection whatever with matters pertaining to currency or standards of value, has been the reduction in the cost of transportation or distribution. Its influence has also necessarily manifested itself very unequally, occasioning the greatest price-reductions in the case of articles—like cereals, meats, fibers, ores, and all coarser materials—in respect to which transportation constitutes the largest element of cost at the place of consumption; and least in the case of articles—like textiles, spirits, spices, teas, books, and similar products—where great values are comprised in small bulk. The investigations of Mr. Atkinson show that, had the actual quantity of merchandise moved by the railroads of the United States in 1880 been subjected to the average rate per ton per mile which was charged from 1866 to 1869, the difference would have amounted to at least $500,000,000 (£100,000,000), and perhaps $800,000,000 (£160,000,000), more than the actual charge of 1880. Comparing 1865 with 1885, Mr. Atkinson further shows that, taking a given weight of goods to be moved from Chicago to New York, one thousand miles, by the New York Central Railroad, 58 per cent of the original value was absorbed in transportation and depreciation of the currency in the former year; while in 1885 only 20 per cent was so absorbed—the charge per ton per mile having fallen from 3·45 cents in 1865 to ·68 of a cent in 1885.

The fall in price for the carriage of commodities by sea has also been as remarkable as the decline in the cost of carriage by land. Freight, on the average, between Calcutta and England had experienced a decline of about 50 per cent in 1885 as compared with 1875. In the case of India wheat transported to England *via* the Suez Canal, the decline in freights was from 71*s.* 3*d.* per ton in October, 1881, to 27*s.* in October, 1885, or more than 63 per cent. Between 1873 and 1885 the tolls and pilotage on the Suez Canal were reduced to the extent of about 33 per cent.

Freights from New York to Liverpool declined, from 1880 to 1886, as follows (maximum and minimum): On grain, from $9\frac{1}{4}$*d.* to 1*d.* per bushel; on flour, from 25*s.* to 7*s.* 6*d.* per ton; on cheese, from 50*s.* to 15*s.* per ton; on cotton, from $\frac{3}{8}$*d.* to $\frac{7}{64}$*d.* per pound; and on bacon and lard, from 45*s.* to 7*s.* 6*d* per ton. Subsequently, prices recovered somewhat, but by no means to the extent of the rates current in 1880 and preceding years.

It is not, however, to be concealed that numerous economists and statisticians of high repute—Mr. Sauerbeck and others—are nevertheless of the opinion that, allowing all that has been claimed for the influence on prices occasioned by reduction of cost through increased and cheapened production and distribution, the decline in recent years is too great to be "simply explained away" by these agencies. But these authorities have specified no commodities, the analysis of whose production and price-experiences in recent years furnish any sufficient foundation for such a general conclusion; and it is interesting to note how the experiences of the few, which at first thought would seem to indicate the sensible influence of "other" agencies, on analysis prove to the contrary. Thus, in the case of wool, Messrs. Helmuth, Swartze & Co., of London, the best recognized authorities on this commodity, in their annual circular for 1887, after admitting the great increase in the production of wool in the years from 1860 to

1886, nevertheless claim that consumption has at the same time increased to such an extent, that the general assumption of an excessive production of this commodity has not been warranted, and in truth has "but slightly exceeded the ordinary growth of population, and that, therefore, other influences must have been at work to cause the great decline in its price which has characterized the course of events during recent years." But to this it may be replied, that when the supply of any commodity exceeds by even a very small percentage what is required to meet every demand for current consumption—specially in the case of a staple commodity like wool, whose every variation in supply and demand is studied every day, as it were microscopically, by thousands of interested dealers and consumers—it is the price which this surplus will command that governs and fixes the price for the whole ; and as this can not be sold readily—as under such circumstances no one buys in excess of present demand, and all desire to dispose of accumulated stocks—the result is a decline of prices, in accordance with no law, and which will be more or less excessive, or permanent, as opinions vary as to the extent of the surplus and the permanence of the causes that have occasioned it.*

Another illustration to the same effect is afforded in the case of silk, which, according to accepted English statistics, has notably declined in price, comparing the average rates of 1867–'77 with those of 1885, without anything like a corresponding increase in supply. Hence the inference would seem warranted, that some other agency than increased and cheapened production had occasioned the decline in price, and that the case was one which affords support to the gold-scarcity theory. But a careful examination of all the involved circumstances discloses the fact, that within recent years materials other than silk—more especially the "ramie" -fiber—largely enter into the composition of silk fabrications—in the case of the cheaper silks of extensive consumption to the extent of even 60 per cent—and that other methods of adulterating silk, formerly but little known, are now extensively practiced ; all of which is equivalent to increasing the supply of silk for manufacturing, far beyond what commercial reports respecting the supply of the fiber would indicate.

Such, then, are the leading and admitted facts illustrative of the nature and extent of the extraordinary and most extensive decline in prices which has occurred in recent years, and which has been the most apparent and proximate (but not the ultimate) cause of the period of economic disturbance which, commencing in 1873, still exists, and seems certain to last for some time longer. Such, also, is a

* The estimates of Messrs. Helmuth, Swartze & Co., were that the wool product of the world increased from 1871–'75 to 1886—or during a period of from eleven to fifteen years—35 per cent ; while the increase in the world's consumption of wool from 1860 to 1886—a period of twenty-five years—was from 2·03 pounds to 2·66 pounds per head, or in the ratio of 30 per cent.

summary of the evidence in support of the view that this recent phenomenal decline of prices is due so largely to the great multiplication and cheapening of commodities through new conditions of production and distribution, that the influence of any or all other causes combined in contributing to such a result has been very inconsiderable, if not wholly inappreciable. Reasoning also from what may be termed the gold standpoint, the evidence to the same effect is not less conclusive.

It would seem, in the first place, that if the scarcity influence of gold on prices had originated and operated as the advocates of this theory claim, such influence would have been as all-pervasive, synchronous, irresistible, and constant as the influence of gravitation; and that something of correspondence, as respects time and degree, in the resulting price-movements of commodities, would have been recognized. But no such correspondence has been or can be established. On the contrary, the movement of general prices since 1873—although generally downward—has been exceedingly irregular; declining until 1878-'79; then rising until 1882-'83; then again declining to an almost unprecedented low average in 1886; and in the year 1887 exhibiting, in respect to some commodities, a slight upward tendency. It might also have been expected that the influence of a scarcity of gold would have especially manifested itself at or shortly subsequent to the time (1873-'74) when Germany, having demonetized silver, was absorbing gold, and France and the Latin Union were suspending the coinage of silver. But the years from 1875 to 1879, inclusive, taking the English market as the criterion, were characterized generally by an excessive supply of money and currency of all kinds; and the same has been true of the period from 1880 to 1886-'87, when, if the supply of money from gold was constantly diminishing, contrary results would seem to have been inevitable.

The divergency in the price-movements of different and special commodities has also been very notable—so much so that, out of the long list of articles embraced in the numerous tables that have been prepared by European economists for determining the general average of prices during recent periods, the price-movements of no two commodities can be fairly regarded as harmonizing. While in the case of some staple products, prices fell immediately and rapidly after 1873, the prices of others, although subjected to the same gold-scarcity influence, and which did not have this influence neutralized by a decline of production concurrent with continuing demand, exhibited for a long time comparatively little or absolutely no disturbance. This was especially the case in respect to wool, the price of which, long after metals, breadstuffs, chemicals, and cotton goods had succumbed to the wave of depression subsequent to 1873, "continued" (to use the language of the trade) "remarkably healthy," notwithstanding a continually-increasing product was recognized; and it was not until 1884 that the decline in the general prices of this commodity gave any occasion for anxiety.

Careful comparisons of price-movements in recent years also fail to show any exact correspondence of results as respects different countries, the average fall of prices having been apparently less in France and Germany than in Great Britain during the same period; while the average fall in prices in the United States, in respect to all those commodities which enter into the general wants of man, have been undoubtedly greater than in any other country.*

Now, while such results are not in accordance with what might have been anticipated *from* and can not be satisfactorily explained *by* any theory of the predominating and depressing influence of a scarcity of gold on prices, they are exactly the results which might have been expected from and can be satisfactorily explained by the conditions of supply and demand—conditions so varying with time, place, and circumstance as to require in the case of every commodity a special examination to determine its price-experience, and which experience, once recognized, will rarely or never be found to exactly correspond with the experience of any other commodity: the leading factor

* The following extract from the "Report of the Chamber of Commerce of Cincinnati, Ohio," for the year ending August 31, 1886, strikingly illustrates the extraordinary decline in the price of staple commodities in this great interior market of the North American Continent:

"There is one condition revealed"—i. e., by the statistics of 1885–'86—"that is very noticeable, which is that prices in general touched the lowest point in a quarter of a century. There were those who supposed that the shrinking processes had been arrested in the preceding year, and yet the figures for 1885–'86, in nearly all departments of business, show lower prices than the previous year. In presence of the low prices of 1884–'85, it seemed almost incredible that so much of market value could be wrung from them as has been during the past year. Thus, commencing near the alphabetical list, bran declined 9 per cent; creamery butter, 20·7; butterine, 18; candles, 18·7; soap, 15·2; cattle, 8; coal, delivered, 7·8; middling cotton, 11·9; feathers, 6·7; dried apples, 27·4; No. 2 mixed (shelled) corn, 14·6; No. 2 oats, 5·3; New Orleans molasses, 11·6; Louisiana rice, 13·1; hay, 5; hops, 25·2; mess-pork, 21·1; prime lard, 10·7; lard-oil, 11·7; tallow, 22; white-leaf tobacco, 25; flax-seed, 18·4; starch, 13·4; high wines, not including the taxes, 16·3. In a few articles—tanners' bark, clover-seed, lead, barley, wool, etc.—there was an advance; yet the number is so small as to make them quite exceptionable.

"While the depreciation which has taken place the past year (1885–'86), compared with the prices of 1884–'85 has been marked, it may be interesting to take a glance at the tremendous reduction which has taken place in the past five years, which, in articles that enter into the every-day wants of man, in not a few instances has been equal to almost one half their value in 1881–'82. The gravitation to a lower plane of value has been so steady as to prevent a full appreciation of the enormous shrinkage to which commodities have been subjected. Thus, in mess-pork the depreciation in the general average price since 1881–'82 has been 48·5 per cent; in prime steam lard, 46; hams, 24·4; shelled corn, 43; oats (which in Europe have shown no tendency in recent years to fall in price), 39·4; rye, 32·6; bran, 33·8; extra butter, 46·9; tallow, 11·4; flour, 34·3; linseed oil, 30; salt, 18·6; cheese, 17·1; fair to medium cattle, 18·3; middling cotton, 21·7; Louisiana rice, 28·9; barley, 18·6; and wool, 15 per cent."

occasioning the recent decline in the prices of sugars having been an extraordinary artificial stimulus; in quinine, the changes in the sources of supply from natural to artificially-cultivated trees; in wheat, the accessibility of new and fertile territory, and the reduction of freight; in freights, *on land*, the reduction in the cost of iron and steel, and *on the ocean* new methods of propulsion, economy in fuel and undue multiplication of vessels; in iron and steel, new processes and new furnaces, affording a larger and better product with less labor in a given time; in certain varieties of wool, changes in fashion, and in others an increase of production in a greater ratio than population and their consuming capacity; in ores and coal, the introduction of the steam-drill and more powerful explosive agents; in cheese, a disproportionate market price for butter; in cotton cloth, because the spindles which revolved four thousand times in a minute in 1874 made ten thousand revolutions in the same time in 1885; in "gum-arabic" and "senna," a war in the Soudan; in wines, a destruction of the vines by disease, etc., etc. And yet all these so diverse factors of influence evolve and harmonize under and, at the same time, demonstrate the existence of a law more immutable than any other in economic science—namely, that when production increases in excess of current market demand, even to the extent of an inconsiderable fraction, or is cheapened through any agency, prices will decline; and that when, on the other hand, production is checked or arrested by natural events—storms, pestilence, extremes of temperature—or by artificial interference—as war, excessive taxation, or political misrule or disturbances—prices will advance; and, between these extremes of influence, prices will fluctuate in accordance with the progressive changes in circumstances and the hopes and fears of producers, exchangers, and consumers.*

It should also not be overlooked that extraordinary price-movements—mainly in the direction of further decline, and as the result of continually changing conditions in the production and supply of commodities—are constantly occurring, and are likely to continue to occur, unless further material progress is in some way to be arrested. Bes-

* In new countries, or countries where industry is confined to the production of a few staple products, like wool, wheat, sugar, etc., a decline in prices exerts a wider and much more disturbing influence than in countries where there is great diversity of industry, and where the sources of income and the opportunities for employment are more numerous and more varied. In the latter all branches of industry are rarely depressed at the same time, and prosperity in some compensates to a certain extent for adversity in others. But, in countries of inferior industrial organization and diversification, the interests of the entire community are so common and united that the tendency is always, for a change of price in one commodity—either rise or fall—to unduly influence the prices of all commodities. And this, according to the London "Statist," is what has been particularly noticeable in Australia, where such a sympathy obtains between the three great products of that country—wool, wheat, and copper—that it rarely happens that one of them droops in price without the price of the others rapidly weakening.

semer-steel rails, which commanded £4 5*s.* in Great Britain in 1886, sold in Belgium in June, 1887, for £3 16*s.*; sugar, which was thought to have touched the lowest possible price in July, 1886—2·92 cents per pound in New York (for fair refining in bond), sold in July, 1887, in the same market, for 2·37½ cents; Western (United States) creamery butter which brought 27¼ cents in November, 1886, declined to 19 cents in July, 1887; while sulphate of quinine, which sold in 1885 for 2*s.* 6*d.* per ounce (60 cents), in 1887, owing to continued cheapening in the production and transportation of cinchona-barks and improvements in manufacture, by which more quinine can be made in from three to five days' time than could, a year or two ago, be produced in twenty by old processes, sells for 1*s.* 8*d.* (40 cents), and one of the largest of the world's manufacturers of quinine, under date of September, 1887, writes, "No one can predict the future of this product, as all past experience goes for naught."

But a more interesting question, and one more pertinent to this discussion than any other, is: has gold, in recent years, as an instrumentality for effecting exchanges (by measuring the relation between the various commodities and things exchanged), really become scarce—at least to the extent of occasioning, through its increase of value or purchasing power, a considerable fall in the prices of all commodities? And on this point the following is a summary of the evidence in favor of and in contravention of such a supposition.* The position taken by the advocates or believers in the gold-scarcity theory, is, in brief, that the production of gold in recent years has largely fallen off and become wholly inadequate to meet the demands for coinage contingent on the increase in the world's trade, wealth, and population; and further, and as a direct consequent, that trade everywhere has been obstructed and depressed; that prices, profits, and wages have fallen, and the burden of public debts and of taxation in general has been augmented.

That the world's annual product of gold—consequent mainly upon the exhaustion of the mines of California and Australia—has largely diminished in recent years is not disputed. Opinions as to the extent of this reduction of supply are, however, widely at variance. This is illustrated by the following tables presented in the "First Report of the British Commission on the Recent Changes in the Relative Values

* To avoid confusion of ideas on this subject, it is desirable that the reader should keep clearly in view that *price* is the expression of the value of a commodity in terms of money, and that the expressions, "fall in prices" and "appreciation of gold," for purposes of the present discussion, mean really one and the same thing. "If you have a fall in prices, you have an appreciation of gold; and if you have an appreciation of gold, you have a fall in prices." The problem presented is, therefore, not has gold appreciated in value or purchasing power—for, a fall in prices being admitted, such a result becomes inevitable and coincident—but has its appreciation been due to something that has befallen commodities, or something that has befallen gold itself, such as scarcity of supply or extraordinary demand?

of the Precious Metals," which gives the estimates of Messrs. Soetbeer, of Germany, and Pixley, of London, two of the best recognized authorities on this subject, as to the average yearly amount of gold available for the supply of coin at different periods since 1850:

Soetbeer.		Pixley.	
1857–'60	£22,780,000	1852–'60	£27,600,000
1861–'70	14,060,000	1861–'70	17,600,000
1871–'80	10,255,000	1871–'80	18,700,000
1881–'84	4,050,000	1881–'85	11,200,000

That trade, in the sense of diminishing volume, has *not* been obstructed, and that the decline in prices in recent years has *not* been occasioned, to any appreciable extent, by reason of the scarcity of gold, would appear to be demonstrated by the evidence that has been herewith presented. For the assertion that wages, generally, have fallen, there is absolutely no foundation, as will be shown hereafter. That profits have fallen must be admitted; but such a result has been due, in almost every case, to the severe competition engendered by the desire to effect sales in face of a continued supply of commodities in excess of any current market demand. While in contravention of the assumption that the supply of gold in recent years has been inadequate to meet the increased demands of the world for coinage, etc., the following facts are in the highest degree pertinent, if not wholly conclusive:

No one doubts that the amount of gold in the civilized countries of the world has largely increased in recent years. M. Soetbeer names $538,000,000 as the increase from 1877 to 1885. It is absolutely certain that the reserves of gold in the principal banks of Europe and the United States have in recent years largely increased, and not diminished. Professor Laughlin estimates this increase to have been "from $177,000,000 in 1870–'80 to $836,000,000 in 1885." In 1871–'74 there was, according to the same authority, "$1 in gold for every $3.60 of the paper circulation of the banks of the civilized world; in 1885 there was $1 of gold for every $2.40; the total note circulation increasing during the same time to the extent of $464,000,000, or 29 per cent." In 1870–'74 the gold reserves amounted to 28 per cent of the total note circulation, and 64 per cent of all the specie reserves; in 1885 "the gold bore a larger ratio to a larger issue of paper, or 41 per cent of the total note circulation, and 71 per cent of the specie reserves. This," as Professor Laughlin remarks, "is a very significant showing. What it means, beyond a shadow of doubt, is that the supply of gold is so abundant that the character and safety of the note circulation has been improved in a signal manner."

Since 1873–'74 Germany has radically modified her metallic circulation, giving preference to and using additional gold, and the United States and Italy have resumed specie payments. But the supply of gold has been sufficient to give to these nations all the gold that they required, without apparently affecting the requirements of other countries.

Again, while the continuing increase in the population of the world, and a more rapid increase in recent years in its production and trade, have certainly necessitated a continually increasing supply of money for effective exchanges, evidence is not wanting to prove that all such requirements have been met and any possible deficiencies in the supply of metallic money fully supplemented through various agencies. The present annual production of gold is enormous compared with any period antecedent to 1850.* Before 1840 its annual production was about $14,000,000; it rose to its highest point—$157,000,000—about 1853; and for the year 1885 (according to the estimate of the Director of the United States Mint) was $101,500,000. The production of silver has also largely increased in recent years ($39,000,000 in 1850, $51,000,000 in 1870, and $124,900,000 in 1885), and no evidence can be produced to show that there has been any actual diminution in its aggregate use by reason of its so-called "demonetization" in any country.

Never before in the history of the world have there been so many and such successful devices invented and adopted for economizing the use of money. Every increase in facilities for banking and for the granting and extension of credits largely contributes to this result; the countries enjoying the maximum of such facilities requiring the smallest comparative amount of coin for their commercial transactions, as is illustrated by the circumstance that while in Great Britain (according to Mulhall) the ratio of metallic money used to the whole commerce of the country is only 20 per cent, the ratio rises in Germany to 34 per cent, in the United States to 58 per cent, and in France to 85 per cent.

Furthermore the banking facilities of the world, according to the same authority, have increased since 1840 eleven-fold; or three times greater than the increase in commerce, and thirty times greater than that of population.

The great reduction in the time and cost of distribution of commodities, and the facility with which purchases can be made and credits transmitted by telegraph, have also resulted, not only in an enormous saving of capital, but also in an ability to transact an increased business with diminished necessity for the absorption and use of actual money. A most striking illustration in proof of this, given by Mr. Fowler ("Appreciation of Gold," London, 1885) is, that while the total British export and import trade, aggregating £6,000,000,000 from 1866 to 1875, was accompanied by an aggregate export and import of £530,000,000 of bullion and specie, an aggregate value from 1876 to 1885 of £6,700,000,000, was moved with the aid of only £439,000,000

* "In the last thirty-five years, one and one third times as much gold has been produced as in the three hundred and fifty-eight years preceding 1850."—LAUGHLIN.

of bullion and specie. The same authority refers to an eminent English firm doing business with the East, as stating that "their business could now be conducted with one fifth of the capital formerly employed," which would seem to warrant the inference that the reduction in the necessity for using so much of their capital as was represented by money had also been proportionate.

For the settlement of international balances—a large function of gold—it is certain that every ounce of this metal—through the great reduction in the time of ocean-transits—is at the present time capable of performing far more service than at any former period; the time for the transmission of coin and bullion having been reduced in recent years between Australia and England from ninety to forty days, and from New York to Liverpool from twelve or fifteen to eight or nine days. Such an increase of rapidity in doing work is certainly equivalent to increase in quantity.

The statistics of clearing-houses, which are everywhere multiplying, also show a continued tendency for the settlement of financial obligations without the intervention of either notes or coin; while in every country which has adopted the "postal money-order" system the rapidity with which the public resort to that method of effecting exchanges is most surprising.*

In estimating the influence of the diminished production of gold in recent years, it is important to bear in mind a point to which attention has been often heretofore called, and that is, that gold and silver are not like other commodities, of which the greater part of the annual production is annually consumed; but that their use for the purpose of effecting exchanges does not involve consumption, except by loss and wear; that the work they have once done they are equally ready to do over and over again, and that every addition to their stock "is an addition to the fund available for exchanges." The aggregate sum by which the yearly average amount of gold available for coining fell off during the period from 1861–'70 as compared with that from 1852–'60,† when the mines of California and Australia were most productive, was (adopting Mr. Pixley's estimates) less than £100,000,000 ($500,000,000), a sum absolutely great, but most inconsiderable—less than one sixth of one per cent—in comparison with the amount of gold believed to have been in existence in civilized countries in 1885;‡

* The number of "postal"-orders issued by the British Post-Office in 1886 was 18,831,164, representing £7,885,317 ($39,226,735); while money-orders, domestic and foreign, were issued during the same year to the amount of £25,012,337 ($125,061,685). In the countries comprising the Postal Union of Europe, the issue of domestic money-orders had risen in 1885 to the large amount of $1,821,000,000.

† It is interesting to note that the yearly average amount of gold available for coinage was greater, according to Mr. Pixley's estimates, from 1871–'80 than from 1861–'70.

‡ M. Sauerbeck estimates the total amount of gold in the form of coin and bullion in Europe (excluding the Balkan Peninsula), the United States, and Australia, at the end of 1884, to have been £645,000,000 ($3,225,000,000).

and that such deficiency—even if a much higher estimate than that of Mr. Pixley's is adopted—has for each and every year for a considerable period been far more than supplemented and made good by the reduction in the amount of capital, in the form of money, which the increased facilities for doing business have permitted and effected, is a proposition also which it would seem could not well be doubted.*

The evidence, therefore, seems to fully warrant the following conclusions: that the tendency of the age is to use continually less and less of coin in the transaction of business;† and that "so far from there being any scarcity of gold, there never was a period in the world's commercial history when the existing quantity was so large as at present, in proportion to the necessity for its use or the purposes it has to serve."

It is also exceedingly interesting and significant to note here how completely the most distinguished advocate of the desirability of enlarging the function and use of silver in coinage has repudiated the idea that the recent phenomenal decline of prices has been occasioned by a scarcity of gold. Thus, under date of April 24, 1886, M. Cernuschi thus writes in the London "Economist": "The fall of prices which is complained of is not due to what has been called a scarcity of gold—a scarcity which is purely imaginary." M. Sauerbeck, in referring to this matter ("Journal of the Royal Statistical Society," September, 1886), also says: "A scarcity" (of gold) "as understood by bankers does not exist. Prices have fallen so much that scarcity is not observable. As Mr. Giffen pointed out, there may be enough for present requirements, and the scarcity will only be felt when prices rise." But if prices have fallen through the ingenuity of man, will prices return to their former level? Certainly not, unless the coming man is less ingenious than his present representatives, and Nature is to be less generous in the future of her resources.

* "The trade of the world is carried on by credit and capital, and any causes affecting these essentials have infinitely greater effect on prices than a slight proportionate increase or decrease in the production of gold. A merchant may not hold ten sovereigns, but he may have capital and credit for ten millions. An ingenious statistician has calculated the capital of the world in 1880 at £46,000,000,000" (sterling—$230,000,000,000), "and if credit and capital have had the main voice in the question of prices, how minute must have been the effect on the markets of an annual reduction in the production of floating capital of ten (sterling) millions per annum, from a short period of most exceptional production; especially when the falling off has been more than balanced by the increased economy in the use of gold!"—Nathaniel Cork, "*What is the True Measure of the Alleged Appreciation of Gold?*" *London, 1883.*

† Repeated investigations made in England in recent years prove that only about 0·6 per cent of coin is used in settling the transactions of banks and bankers of that country; and the results of an inquiry instituted by the United States Controller of the Currency in 1881 showed that of all the receipts by 1,966 national banks in one day in that year (June 30th), 95 per cent were made up of forms of credit, exclusive of even circulating notes; while for New York city the percentage was 98·7. At all the banks the proportion of gold coin to the whole receipts was only ·65 of 1 per cent.

The answer of Mr. R. Inglis Palgrave, an English economist of repute, who has recently published extensive memoranda on prices, to a question put to him by the British Gold and Silver Commission (1886), as to "how far the drop in prices is attributable to the alteration in the use of the gold standard," is also worthy of note, and was as follows: "In my opinion it is only a small part of the drop in prices which is attributable to the appreciation of the standard." The present and rapidly increasing indifference of the business public, alike in Europe and the United States, whose interest in this subject is mainly practical, is also significant, as indicating that the importance formerly conceded to the gold-scarcity theory has not been confirmed by experience.

It will be further relevant to this discussion to call attention here to the manner in which certain admitted facts touching the recent fall in prices have been misunderstood, and, more especially, have been perverted, with a view of sustaining this same theory and of creating exaggerated ideas respecting impending disasters, and the power of legislation to provide remedies. Thus, in illustration of the assumption that the quantity of gold in the world, available for use as money, mainly regulates prices, and that, prices having fallen by reason of a scarcity of gold, the ratio of debts to assets, or the burdens upon debtors, has been increased, Mr. Moreton Frewen, of England, has frequently in recent years made the following statement: Premising that the national debt of the United States was £600,000,000 sterling ($3,000,000,000) in 1866, and £220,000,000 ($1,100,000,000) in 1887, he says:

"Six hundred millions sterling owing in 1866 represent 18,000,000 bales of cotton, or 25,000,000 tons of bar-iron. But at the prices of to-day, only £220,000,000 sterling is represented by some 26,000,000 bales of cotton, or 29,000,000 tons of bar-iron."

Therefore, the burden of the national debt of the United States has been increased, as a greater effort of labor, or an increased amount of the products of labor, is now necessary to liquidate it than when the purchasing power of gold had not been appreciated through its scarcity; and, as with public debts, so also with private debts, especially those in the nature of mortgages on land, or other productive fixed capital.

Now, in reply to this it is to be said, *first*, that the basis assumed for this comparison of prices, in the case of cotton, is entirely unfair and unnatural—the *gold* price of this commodity in the year 1866, owing to a scarcity occasioned by war, having been more than 250 per cent higher than the average prices in 1860 before the war; while the price of iron for that same year in the American markets was also inflated on even a gold basis; and, *secondly*, that no consideration is given, or allowance made in the above comparisons for the results of labor at the two periods of 1866 and 1887; not more, and probably much less, actual labor in 1886–'87 having produced 6,513,000 bales of cotton in the United States than was required in 1860 to produce 3,800,000 bales ;* while in the case of iron the same amount of labor will produce in 1887 more than double the quantity, in the more valuable form of steel, than it could have produced in 1886. In short, if the debtor has got more to pay, he has more to pay with.

Again, it is a popular idea that the steadily increasing supply to the markets of the world during recent years of wheat, the product of low-priced labor from India—seriously affecting, through its competition, the prices and profits alike of the agriculturists of the United States and of Europe—has been in some way occasioned by the change in the relative values or purchasing powers of gold and silver, consequent on the "demonetization" of the latter metal—although no one as yet has been able to trace with any degree of clearness any connection between the two facts—and that an imperative necessity exists for some speedy and international remedial legislation. To all entertaining this idea, the following summary of evidence, brought out by the British Gold and Silver Commission in the course of their investigations prosecuted during the present year (1887), is especially worthy of attention : †

There was practically no trade or movement in wheat between Europe and India until two or three years after the opening of the Suez Canal, or until about 1873 ; in which year exportations were further encouraged by the removal of an Indian export duty on wheat of about 6 per cent. In June, 1881, and June, 1886, the prices of Cawnpore wheat at Calcutta were at the same level, namely, 2·9 rupees per maund. The cost of Indian wheat in London in 1881 was 42*s.* a quarter, and 31*s.* 6*d.* in 1886, or 10*s.* 6*d.* difference. In 1881 the rate of freight on wheat from India to London was 60*s.* per ton, and in 1886 30*s.*, a difference of 30*s.* per ton, or 6*s.* 6*d.* per quarter. The decline in freights, therefore, accounts for 6*s.* 6*d.* out of the 10*s.* 6*d.* per quarter

* The increase in the cotton product of the United States since 1860 has been due mainly to the increased use of fertilizers, better tillage, better conditions for the employment of labor. In the Brazos alluvial region of Texas, which ranks among the first of cotton-producing regions, the relative increase in cotton product and population between 1870 and 1880, according to the United States census, was 1·8 to 1. In what is termed the "oak-upland" regions of North Carolina, the product of cotton in 1880 had increased over that of 1870 in the ratio of 4·5 to 1, or this region in 1880 produced more cotton than the product of the entire State in either 1870 or 1860. "This remarkable result," according to the special United States census report on cotton for 1880, "was due mainly to the introduction and general use of commercial fertilizers, which not only increase the crop, but hasten its maturity from two to three weeks, and so bring into the cotton belt a strip of plateau country whose elevation, of from 800 to 1,200 feet, had placed it just beyond the climatic range of the cotton-plant. This change is in no respect due to altered relations of labor."

† See "First Report of the British Commission"—evidence of Henry Waterfield, C. B., Financial Secretary of the India Office, and representing the Government of India, pp. 125, 126.

difference between the prices of Indian wheat in London in 1881 and 1886, respectively, leaving 4s. per quarter to be contributed by other agencies. Between 1879 and 1886 the charge for the railway transport of grain between Cawnpore and Calcutta (684 miles) was reduced to the extent of about 2s. per quarter, which represented to the purchaser in Calcutta an equivalent reduction in the cost of Indian production, and in the absence of which the Calcutta and European prices would obviously have been correspondingly increased. A further reduction of 6d. per quarter "is probably owing to a decline, during the same period, in the price of the gunny-bags" in which the wheat is transported; leaving 3s. 6d. per quarter, which may not unreasonably be referred to, and fully accounted for, by the extraordinary decline of more than 12s. per quarter, between the years 1880 and 1885, in the export price of American wheat; which, as the largest factor in determining the world's surplus of this commodity, is also necessarily the largest factor in determining what shall be the price of this surplus in the world's market.

Evidence was also submitted to the British Trade Depression Commission in 1866, to the effect that the increase of the acreage under wheat in India "exactly agrees with the development of the Indian railways," and that "when more railways are made in India, a very much larger wheat production will immediately follow." *

* On this subject, the following testimony was submitted to the British Commission on the Depression of Trade, 1886, by Mr. W. J. Harris, who is recognized as an authority in England on agricultural subjects:

"Our Indian Empire seems able to extend its corn-growing industry to almost any extent, and to produce more cheaply than any other country in the world. I am aware that Sir James Caird gave a somewhat different evidence on this question, but I think that neither Mr. Giffen nor Sir James Caird have taken sufficiently into account one or two things in their statistical computation. They both maintain that the population of India is too large, or is getting too large, for the means of production. They do not seem to remember that every unit of population in India consumes about a fifth part of what the unit of population in the United States does. It is a comparison between India and the United States. Both Sir James Caird and Mr. Giffen admit that the capabilities of the United States are very enormous, but they think that the capabilities of India are comparatively very small. I differ from them, and I will give my reasons. If we follow (on the maps of India) the course of the railways which have been made for some time, you will find that the acreage under wheat exactly agrees with the development of those railways; and it appears to me that when more railways are made in India, a very much larger wheat production will immediately follow. I have made several inquiries from the principal merchants who do business with India, and who have agents at many central points, and they all agree that the wheat production in India is not nearly developed yet. The population is not encroaching on the means of subsistence so much as the mere statistician would argue, because he does not take into account the habits of the people; and I believe that the United States population, in consequence of the habits of its people, is encroaching just as fast on their means of subsistence as are the people of India. There is a large acreage in India that is not fully cultivated with anything at the present time, and, where it is, it is very imperfectly cultivated, and the prices of produce are exceeding low in places remote from railway communication. Agriculture is very

The evidence, therefore, warrants the belief that the fall in recent years in the price of Indian wheat, and its consequent appearance as an important element of supply in European markets, is to be accounted for mainly, if not entirely, by changes in the conditions of its production and supply, and not by any changes in the relative values of gold and silver; and further, that if every measure for extending the monetary use of silver, which has been proposed, should be carried out to the fullest extent, it would produce no sensible influence in restraining the Indian ryot from competing with American and European agriculturists in the sale of wheat in the world's markets.

AGASSIZ AND EVOLUTION. *

By Professor JOSEPH LE CONTE.

In order to clear up the conception of evolution, it is necessary to give a brief history of the idea, and especially to explain the relation of Louis Agassiz to that theory. This is the more necessary, because there is a deep and wide-spread misunderstanding on this subject, and thus scant justice has been done our great naturalist, especially by the English and Germans; and also because this relation is an admirable illustration of an important principle in scientific philosophy.

Like all great ideas, we find the first germs of this in Greek philosophy, in the cosmic speculations of Thales and Pythagoras. Next (about 100 B. C.) we find it more clearly expressed by the Roman thinker, Lucretius, in his great philosophic poem entitled "De Rerum Natura." After a dormancy of nearly eighteen centuries it next emerges with still more clearness in the theological speculations of Swedenborg and the philosophical speculations of Kant. All these we pass over with bare mention, because these thinkers approached the subject from the philosophic rather than the scientific side—in the metaphysical rather than the scientific spirit.

The first serious attempt at scientific presentation of the subject was by the celebrated naturalist, Lamarck, in a work entitled "Philosophie Zoölogique," published in 1809. It is not necessary, in this rapid sketch, to give a full account of Lamarck's views. Suffice it to say that the essential idea of evolution, viz., the indefinite variability and the derivative origin of species, was insisted on with great learning and skill, and illustrated by many examples. With Lamarck, the factors of evolution or causes of change of organic forms were—1. Modification of organs in function and therefore in structure, by a

rude; they have very little machinery. The system might be greatly improved, and the produce thereby increased."—*Third Report on the Depression of Trade*, pp. 82, 83.

* From advance sheets of Professor Le Conte's work on "Evolution and its Relation to Religious Thought," in preparation by D. Appleton & Co.

changing environment—external factor; and, 2. Modification of organs by *use* and *disuse*—internal factor. In both cases the modifications are inherited and increased from generation to generation, without limit. This second factor seems to have taken, in the mind of Lamarck, the somewhat vague and transcendental form of aspiration or upward striving of the animal toward higher conditions. These are acknowledged to-day as true factors of evolution, but the distinctively Darwinian factor, viz., "divergent variation and natural selection," was not then thought of. The publication of Lamarck's views produced a powerful impression, but only for a little while. Pierced by the shafts of ridicule shot by nimble wits of Paris, and crushed beneath the heavy weight of the authority of Cuvier, the greatest naturalist and comparative anatomist of that or perhaps of any time, it fell almost still-born. I believe it was best that it should thus perish. Its birth was premature; it was not fit to live. The world was not yet prepared for a true scientific theory. Nevertheless, the work was not without its effect upon some of the most advanced thinkers of that time; upon Saint-Hilaire and Comte in France, and upon Goethe and Oken in Germany. It was good seed sown and destined to spring up and bear fruit in suitable environment; but not yet.

The next attempt worthy of attention in this rapid sketch is that of Robert Chambers, in a little volume entitled "Vestiges of a Natural History of Creation," published in 1844. It was essentially a reproduction of Lamarck's views in a more popular form. It was not a truly scientific work nor written by a scientific man. It was rather an appeal from the too technical court of science to the supposed wider and more unprejudiced court of popular intelligence. It was therefore far more eloquent than accurate; far more specious than profound. It was, indeed, full of false facts and inconsequent reasonings. Nevertheless, it produced a very strong impression on the thinking, popular mind. But *it* also quickly fell, pierced by keen shafts of ridicule, and crushed beneath the heavy weight of the authority of all the most prominent naturalists of that time, with Agassiz at their head. The question for the time seemed closed. I believe, again, it was best so, for the time was not yet fully ripe.

I know full well that many think with Haeckel that biology was kept back half a century by the baneful authority of Cuvier and Agassiz; but I can not think so. The hypothesis was contrary to the facts of science *as then known and understood*. It was conceived in the spirit of baseless speculation, rather than of cautious induction; of skillful elaboration rather than of earnest truth-seeking. Its general acceptance would have debauched the true spirit of science. I repeat it: the time was not yet ripe for a scientific theory. The ground must first be cleared and a solid foundation built; an insuperable *obstacle* to hearty rational acceptance must first be removed, and an inductive *basis* must be laid.

The obstacle in the way of the acceptance of the derivative origin of species was the then prevalent *notion concerning the nature of life.* We must briefly sketch the change which has taken place in the last forty years in our ideas on this subject.

Until about forty years ago, the different forces of Nature, such as gravity, electricity, magnetism, light, heat, chemical affinity, etc., were supposed to be entirely distinct. The realm of Nature was divided up into a number of distinct and independent principalities, each subject to its own sovereign force and ruled by its own petty laws. About that time it began to be evident, and is now universally acknowledged, that all these forces are but different *forms* of one, universal, omnipresent energy, and are transmutable into one another back and forth without loss. This is the doctrine of correlation of forces and conservation of energy, one of the grandest ideas of modern times. But *one* force seemed still to be an exception. Life-force was still believed to be a peculiar, mysterious principle or entity, standing above other forces and subordinating them; not correlated with, not transmutable unto, nor derivable from, other and lower forces, and therefore in some sense supernatural. Now, if this be true of living *forces*, it is perfectly natural, yea, almost necessary, to believe that living *forms* are wholly different from other forms in their origin. New forms of dead matter may be derived, but new living forms are *underived.* Other new forms come by natural process, new organic forms by supernatural process. The conclusion was almost unavoidable. But soon vital force also yielded to the general law of correlation of natural forces. Vital forces are also transmutable into and derivable from physical and chemical forces. Sun-force, falling on the green leaves of plants, is absorbed and converted into vital force, disappears as *light* to reappear as *life.* The amount of life-force generated is measured by the amount of light extinguished. The same is true of animal life. As in the steam-engine the locomotive energy is derived from the fuel consumed and measured by its amount, so in the animal body the animal heat and animal force are derived from and measured by the food and tissue consumed by combustion. Thus, vital force may be regarded as so much force withdrawn from the general fund of chemical and physical forces, to be again refunded without loss at death. This obstacle is, therefore, now removed. If vital force falls in the same category as other natural forces, there is no reason why living forms should not fall into the same category in this regard as other natural forms. If new forms of dead matter are derived from old forms by modification, according to *physical* laws, there is no reason why new living forms should not also be derived from old forms by modification according to *physiological* laws. Thus, at last, the obstacle was removed—the ground was cleared.

But Science is not content with removal of *a priori* objections. She must also have positive proofs. The ground must not only be cleared, but a true inductive basis of facts, and especially of laws and methods, must be laid. *This was the life-work of Agassiz.* Yes, as strange as it may seem to some, it is nevertheless true that the whole inductive basis, upon which was afterward built the modern theory of evolution, was laid by Agassiz, although he himself persistently refused to build upon it any really scientific superstructure. It is plain, then, that all attempts at building previous to Agassiz's work must, of necessity, have resulted in an unsubstantial structure—an edifice built on sand, which could not and ought not to stand. I must stop here in order to explain somewhat fully this important point, and thus to give due credit to the work of Agassiz.

The title of any scientist to greatness must be determined, not so much by the multitude of new facts he has discovered as by the new laws he has established, and especially by the new methods he has inaugurated or perfected. Now, I think it can be shown that to Agassiz, more than to any other man, is due the credit of having *established the laws of succession of living forms* in the geological history of the earth—laws upon which must rest any true theory of evolution. Also, that to him, more than to any other man, is due the credit of having *perfected the method* (method of comparison) by the use of which alone biological science has advanced so rapidly in modern times. This is high praise. I wish to justify it. I begin with the method.

Scientific methods bear the same relation to *intellectual progress* that tools, instruments, machines, mechanical contrivances of all sorts, bear to *material progress.* They are intellectual *contrivances*—indirect ways of accomplishing results far too hard for bare-handed, unaided intellectual strength. As the civilized man has little or no advantage over the savage in bare-handed strength of muscle, and the enormous superiority of the latter in accomplishing material results is due wholly to the use of mechanical contrivances or machines; even so, in the higher sphere of intellect, the scientist makes no pretension to the possession of greater unaided intellectual strength than belongs to the uncultured man, or even perhaps to the savage. The amazing intellectual results achieved by science are due wholly to the use of intellectual contrivances or scientific methods. As in the lower sphere of material progress the greatest benefactors of the race are the inventors or perfecters of new mechanical contrivances or *machines,* so also in the higher sphere of intellectual progress the greatest benefactors of the race are the inventors or perfecters of new intellectual contrivances or *methods of research.*

To illustrate the power of methods, and the necessity of their use, take the case of the *method of notation,* so characteristic of mathematics, and take it even in its simplest and most familiar form: Nine numeral figures, having each a value of its own, and another dependent upon its position; a few letters, a and b, and x and y, connected by symbols, $+$ and $-$ and $=$: that is all. And yet, by the use of this simple contrivance, the dullest school-boy accomplishes intellectual results which would defy the utmost efforts of the unaided strength of the greatest genius. And this is only the simplest tool-form of this method. Think of the results accomplished by the use of the more complex machinery of the higher mathematics!

Take next the method of experiment so characteristic of physics and chemistry. The phenomena of the external world are far too complex and far too much affected by disturbing forces and modifying conditions to be understood at once by bare, unaided intellectual insight. They must first be simplified. The physicist, therefore, contrives artificial phenomena under ideal conditions. He removes one complicating condition after another, one disturbing cause and then another, watching meanwhile the result, until finally the necessary condition and the true cause are discovered. On this method rests the whole fabric of the physical and chemical sciences.

But when we rise still higher, viz., into the plane of life, the phenomena of Nature become still more complex and difficult to understand directly; and yet just here, where we are the most powerless without some method, our method of experiment almost wholly *fails us*. The phenomena of life are not only far more complex than those of dead matter, but the conditions of life are so nicely adjusted, the equilibrium of forces so delicately balanced, that, when we attempt to introduce our clumsy hands in the way of experiment, we are in danger of overthrowing the equilibrium, of destroying the conditions of the experiment, viz., life; and then the whole problem falls immediately into the domain of chemistry. What shall we do? In this dilemma we find that Nature herself has already prepared for us, ready to hand, an elaborate series of simplified conditions equivalent to experiments. The phenomena of life are, indeed, far too complex to be at once understood—the problem of life too hard to be solved—in the higher animals; but, as we go down the animal scale, complicating conditions are removed one by one, the phenomena of life become simpler and simpler, until in the lowest microscopic cell or spherule of living protoplasm we finally reach the simplest possible expression of life. The equation of life is reduced to its simplest terms, and now, if ever, we begin to understand the true value of the unknown quantity. This is the natural history series, or *Taxonomic* series, already spoken of. Again, Nature has prepared, and is now preparing daily before our eyes, another series of gradually simplified conditions. Commencing with the mature condition of one of the higher animals—for example, man—and going backward along the line of individual history through the stages of infant embryo, egg, and germ—we find again the phenomena of life becoming simpler and simpler, until we again reach the simplest conceivable condition in the single microscopic cell or spherule of living protoplasm. This, as already explained, is the embryonic or *Ontogenic* series. Again, that there be no excuse for man's ignorance of the laws of life, Nature has prepared still another series; and this the grandest of all, for it is the cause of both the others. Commencing with the plants and animals of the present epoch, and going back along the track of geological times, through Cenozoic, Mesozoic, Palæozoic, Eozoic, to the very dawn of life—the first syllable of recorded time—and we find again a series of organic forms growing simpler and simpler, until, if we could find the very first, we would undoubtedly again reach the simplest condition in the lowest conceivable forms of life. This, as we have already seen, is the geologic or evolution, or *Phylogenic* series. We have already explained these three series, only in this connection it suits our purpose to take the terms backward.

Now, it is by *comparison* of the terms of each of these series going up and down, and watching the first appearance, the growth, and the perfecting of tissues, organs, functions, and by the comparison of the three series with one another, term by term—I say it is wholly by comparison of this kind that biology has in recent times become a true inductive science. This is the "*method of comparison.*" It is the great method of research in all those departments which can not be readily managed by the method of experiment. It has already regenerated biology, and is now applied with like success in sociology under the name of *historic method.* Yes; anatomy became scientific only through comparative anatomy, physiology through comparative physiology, and embryology through comparative embryology. May we not add, sociology will become truly scientific only through comparative sociology, and psychology through comparative psychology?

Now, while it is true that this method, like all other methods, has been used, from the earliest dawn of thought, in a loose and imperfect way, yet it is only in very recent times that it has been organized, systematized, perfected, as a true scientific method, as a great instrument of research; and the prodigious recent advance of biology is due wholly to this cause. Now, among the great leaders of this modern movement, Agassiz undoubtedly stands in the very first rank. I must try to make this point plain, for it is by no means generally understood.

Cuvier is acknowledged to be the great founder of comparative anatomy. He it was that first perfected the method of comparison, but comparison only in one series—the *Taxonomic.* Von Baer and Agassiz added to this, comparison in the ontogenic series also, and comparison of these two series with each other, and therefore the application of embryology to the classification of animals. If Von Baer was the first announcer, Agassiz was the first great practical worker by this method. Last and most important of all, in its relation to evolution, Agassiz added *comparison in the geologic or phylogenic series.* The one grand idea underlying Agassiz's whole life-work was the essential identity of the three series, and therefore the light which they must shed on one another. The two guiding and animating principles of his scientific work were—1. That the embryonic development of one of the higher representatives of any group repeated in a general way the terms of the taxonomic series in the same group, and therefore that embryology furnished the key to a true classification; and, 2. That the succession of forms and structure in geological times in any group is similar to the succession of forms and structure in the development of the individual in the same group, and thus that embryology furnishes also the key to geological succession. In other words, during his whole life, Agassiz insisted that the laws of embryonic development (ontogeny) are also the laws of geological succession (phylogeny). Surely this is the foundation, the only solid foundation, of a true theory of evolution. It is true that Agassiz, holding as he did the doctrine of permanency of specific types, and therefore rejecting the doctrine of the derivative origin of species, did not admit the causal or natural relation of phylogenic succession to embryonic succession and taxonomic order as we now believe it—it is true that for him the relation between the three series was an intellectual not a physical one—consisted in the preordained plans of the Creator, and not in any genetic connection or inherited property; but evidently the first and greatest step was the discovery of the relation itself, however accounted for. The rest was sure to follow.

But more. Not only did Agassiz establish the essential identity of the geologic and embryonic succession, the general similarity of the two series, phylogenic and ontogenic, but he also announced and enforced all the formal laws of geologic succession (i. e., of evolution) as we now know them. These, as already stated and illustrated, are the law of differentiation, the law of progress of the whole, and the law of cyclical movement, although he did not formulate them in these words. No true inductive evidence of evolution was possible without the knowledge of these laws, and for this knowledge we are mainly indebted to Agassiz. He well knew also that they were the laws of embryonic development and therefore of evolution; but he avoided the word evolution, as implying the derivative origin of species, and used instead the word *development*, though it is hard to see in what the words differ. Thus, it is evident that Agassiz laid the whole foundation of evolution, solid and broad, but refused to build any scientific structure on it; he refused to recognize the legitimate, the scientifically necessary outcome of his own work. Nevertheless, without his work a scientific theory of evolution would have been impossible. Without Agassiz (or his equivalent), there would have been no Darwin.

There is something to us supremely grand in this refusal of Agassiz to accept the theory of evolution. The opportunity to become the leader of modern thought, the foremost man of the century, was in his hands, and he refused, because his religious, or, perhaps better, his philosophic intuitions, forbade. To Agassiz, and, indeed, to all men of that time, to many, alas! even now, evolution is materialism. But materialism is atheism. Will some one say, the genuine Truth-seeker follows where she seems to lead, *whatever be the consequences?* Yes; whatever be the consequences to one's self, to one's opinions, prejudices, theories, philosophies, but not to *still more certain truth*. Now, to Agassiz, as to all genuine thinkers, the existence of God, like our own existence, is more certain than any scientific theory, than anything can possibly be made by proof. From his standpoint, therefore, he was right in rejecting evolution as conflicting with still more certain truth. The mistake which he made was in imagining that there was any such conflict at all. But this was the universal mistake of the age. A lesser man would have seen less clearly the higher truth and accepted the lower. A greater man would have risen above the age, and seen that there was no conflict, and so accepted both. All thinking men are coming to this conclusion now, but none had done so then.

Now, then, at last, the obstacle of supernaturalism in the realm of Nature having been removed by the establishment of the doctrine of correlation of natural forces, and the extension of this doctrine to embrace also life-force; and now also a broad and firm basis of carefully-observed facts and well-established laws of succession of organic forms having been laid by Agassiz, when again, for the third time, the doctrine of origin of species "by derivation with modifications" was brought forward by Darwin in a far more perfect form, with more abundant illustrative materials, and with a new and most potent factor of modification—viz., divergent variations and natural selection—it found the scientific world already fully prepared, and anxiously waiting. I say *anxiously* waiting—for the supposed supernatural origin of species had been the one exception to the otherwise universal law of cause and effect, or the law of continuity. It was therefore an open contradiction to the whole drift of scientific thought for five hundred years. Is it any wonder, then, that the derivative origin of species was welcomed with joy by the scientific world? For five hundred years, scientific thought, like a rising tide which knows no ebb, had tended thitherward with ever-increasing pressure, but kept back by the one supposed fact of the supernatural origin of species. Darwin lifted the gate, and the in-rushing tide flooded the whole domain of thought.

What, then, is the place of Agassiz in biological science? What is the relation of Agassiz to Darwin—of Agassizian development to Darwinian evolution? I answer, it is the relation of formal science to physical or causal science. Agassiz advanced biology to the *formal* stage; Darwin carried it forward, to some extent at least, to the *physical* stage. All true inductive sciences in their complete development pass through these two stages. Science in the one stage treats of the *laws* of phenomena; in the other, of the *causes* or explanation of these laws. The former must precede the latter, and form its foundation; the latter must follow the former, and constitute its completion. The change from the one to the other is always attended with prodigious impulse to science.

To illustrate: Until Kepler, astronomy was little more than an accumulation of disconnected facts concerning celestial motions—abundant materials, but no science; piles of brick and stone, but no building. Kepler reduced this chaos to beautiful order and musical harmony by the discovery of the three great laws which bear his name, and therefore he has been justly called the legislator of the heavens—*the lawgiver of space.* But, had he been asked the *cause* of these beautiful laws, he could only have answered, "The *first cause*—the direct will of the Deity." A good answer and a true, but not scientific; because it places the question beyond the domain of science, which deals only with second or physical causes. But Newton comes forward and gives a *physical cause.* He shows that all these beautiful laws are the necessary result of gravitation; and thus astronomy becomes a physical science. So, until Agassiz, the facts of geological succession of organic forms were in a state of lawless confusion. Agassiz by establishing the three great laws of succession, which ought to bear his name, reduced this chaos to order and beauty; and, therefore, he might justly be called the legislator of geological history—the *lawgiver of time.* But, when asked the cause of these laws, he could only answer, and did indeed answer, "The plans of the Creator." A noble answer and true, but not scientific. Darwin now comes forward and gives, partly at least, the cause of these laws. He shows that all these beautiful laws are explained by the doctrine of "origin of species by derivation with modifications"; that these laws are not ultimate, but derivative from more fundamental laws of life; and thus biology is advanced one step, at least, toward the causal stage. Newton and Darwin substituted second causes for first cause—natural for supernatural. They each in his own department broke the bonds of supernaturalism in the domain of Nature.

One more important reflection: There are two, and only two, fundamental conditions of material existence—*space* and *time.* There are, therefore, two, and only two, cosmoses—space-cosmos and time-cosmos. These have been redeemed from confusion and reduced to law and order and beauty—changed from chaos to cosmos—by science. For this result we are chiefly indebted, in the one case, to Kepler and Newton; in the other, to Agassiz and Darwin. The universal law, in the one cosmos, is the *law of gravitation;* in the other, the *law of evolution.* Traced by analysis to its deepest roots of philosophic truth, the one law may be called the divine mode of sustentation; the other, the divine process of creation.

Or, again: we have all heard of the "music of the spheres"—a beautiful and significant name used by the old thinkers for the divine order of the universe—a music heard not by human ear, but only by the attentive human spirit. Harmonic relation apprehended by *reason* we call *Law*, and its embodiment Science; the same apprehended by the imagination and æsthetic sense, we call *Beauty*, and its embodiment *Art, music*. Now, in music there are two kinds of harmony, simultaneous and consecutive—chordal harmony and melody. These must be combined to produce the grandest effect. So in cosmic order, too, there are two kinds of harmonic relation—the *coexistent in space* and the *consecutive in time*. The law of gravitation expresses the universal harmonic inter-relation of *objects* coexistent in space, the law of evolution, the universal harmonic relation of *forms* successive in time. Of the divine spheral music, the one is the chordal harmony, the other the consecutive harmony or melody. Combined they form the divine chorus which "the morning stars sang together."

SPECIALIZATION IN SCIENCE.

By Professor G. H. THEODOR EIMER.

A JESUIT with whom I was conversing on educational questions once told me, in depreciation of my position as a man of science, that the naturalist of to-day can be a physiologist or a physicist, mineralogist, geologist, zoölogist, botanist, or chemist, and no more; that he can not overlook the whole of science, but can at most only really know a part of his own branch, from which he is not, of course, justified in drawing any general conclusion. It was otherwise with the Jesuit, who excluded himself from no department of knowledge. This man touched accurately what is now recognized as a growing peril to the general significance of science in mental development—the continuous contraction of the individual's field of labor, or specializing. It is right for naturalists in these days to make themselves masters in their own branch, and masters usually in that alone, unless they are in a position to obtain a survey over the whole of the sciences. But it is wrong, in the present condition of knowledge, to deny them a general acquaintance with all scientific matters. That would be to put their capacity below that of the Jesuit, who only desires to obtain a superficial view of science in order to aid him in holding his position in sophistical disputations against it and in favor of his own dogma. Most naturalists and scientifically educated persons have, moreover, been trained in a liberal range of studies, and are well qualified to form a judgment on general scientific as well as upon important and fundamental philosophical questions. Yet we are living, to a large extent, upon the provision left by the fathers. The dividing up is daily becoming more and more minute, and is destined in time to throw a broad shadow over the outlook, unless the demand for a many-sided basis of training as a defense against the evil is universally insisted upon. It is not necessary to have always at hand, at every moment of life, all the details of knowledge which one has once made his own, any more than it is to put what one learns to immediate practical use; if it were so, we should be at a loss to determine the value of the gymnasial training which demands the best of the time and the best of the strength of our youth. This principle, and the danger of promoting a one-sided practical training, in specialties, as opposed to general culture and more ideal views of life, were entirely lost sight of when the Imperial Government a few years ago made the far-reaching step in the direction—which was itself opposed from the practical side—of curtailing the required preparatory scientific instruction of physicians.

From this point of view the words receive a new prominence, which State Minister Von Gossler recently spoke in welcoming the fifty-ninth meeting of the German Naturalists and Physicians to Berlin. "The number of those," he said, "who have accurately mastered most of the branches of science seems to be growing less, and the question whether another mind will ever appear who will be able to write a 'Cosmos' for his time is becoming harder to answer. And yet the conviction remains inextinguishable that there is a 'Cosmos' and there must be a 'Cosmos.' It is certainly necessary that an incessant accumulation of scientifically ascertained facts shall continue to go on, whether by the way of logical comparison or by the aid of the imagination, and lead to the acquisition of new theories and new conceptions. But the other principle is just as valid, that the essential nature and the law of what is can not be apprehended without a harmonious intimate association of the individual sciences; and the perception is perhaps constantly becoming more clear that the separation among the branches of knowledge has its ultimate reason in the limitations and finitude of human power. Where we formerly thought we were in the presence of a number of forces and unknown causes, we now try to discern one force in different forms of manifestation; and we can not exclude the thought that the great progress that can be shown in single branches of science, is in many respects a kind of induction effect of that which is made in other branches."

These are golden words, which might well be applied by the state in the training of its citizens—particularly in the circle of the higher schools. Is it not by specializing carried to an extreme that our gymnasial teachers have devoted themselves to the ancient languages, till they are hardly competent to do any better work than to carry youth through these, their specialties during nine years, without their pupils giving a glance at the all-forming spirit of Nature around them? Let me be permitted to add to Minister Von Gossler's expressions a word of protest against this most untimely and damaging of all specializing, in favor of the sciences, which are treated by the schools in so step-motherly a way. There is an impression still current that scientific training is mischievous to the "peaceful citizen"; that it fits him to plot against the order of the state, or leads him to adopt extreme views in politics and religion. On the contrary, I believe that the importance and value of scientific training must be recognized by every unprejudiced observer in the sound, tolerant, temperate bearing which scientifically educated members of society maintain with reference to questions of public life; which is evident both in itself and as compared with the bearing of men in other conditions. Nothing promotes free, independent thought in men, so well as the sense of obligation to the demands of the generality, so much as the knowledge of the great diversity with unity and the all-prevailing order that rule in Nature. Against the demands of priestly rule and anarchical lawlessness, natural science asks for freedom of movement and orderly subjection, insisting that both are necessary conditions. It must be conceded that neither the order of the theologians nor that of the Jesuits, notwithstanding the nature of both in principle inclines to the conservative rule, affords relatively so few representatives of extreme or radical tendencies as that of the naturalists. The time certainly can not be far distant when the natural sciences shall be given a very different position from that they now hold in general education. Only they can, in the future, furnish the basis, which is becoming more needed as the significance of our public life increases, for the removal of unnatural contradictions in the thoughts of men, for the bringing on of sound, practical, and likewise ideal—I might say, normal—views on the fundamental questions of human society and human life; after exclusive theological and philosophical instruction in these matters has been abrogated.

What an amount of contention, strife, misunderstanding, and hostility among men might have been extinguished or prevented by a more general knowledge of the relative importance of natural processes and laws! Yet the great majority—and of "educated" men, too—even in Germany, die without having obtained more than a vague knowledge of the structure and functions of their own bodies, and that only serving to the preservation of bodily health. And this deficiency is associated through life with the erroneous and cruel doctrine that there is an impassable gap between man and the rest of Nature; while the best force of instruction is wasted upon fruitless philosophical speculations that contradict the most incontestable principles of natural science. Still these zealots demand for their faith the right to stand at the head of the schools and of the state. Should it not be the task of the state to provide for the filling up of the gulf which is thus kept open amid the most fundamental ideas of men, by means of an education conducted on a scientific basis? But the state unwittingly fosters these contradictions of spirit and fritters away its resources, when it leaves its most important representatives, the jurists, who, by the practical nature of their calling and the many-sided character of their relationships, should have the broadest fundamental training, to grope in as complete a childish ignorance of natural things as the narrowest specialists in the service. That we of the present day in Germany have made so little advance in obtaining for science its proper place in education is certainly not least due to the reserve which our learned men usually observe with reference to questions of public life, and especially to their voluntary burial of themselves in special fields.

It is persistent application to special work that naturally forces the student so far away from all contact with things without, and which, while it makes him a monarch on his own little field, frequently also makes his circuit too narrow and himself too self-important. It is not my purpose to condemn the specializing of science, and occupation with a single branch, in themselves. The more a man studies one thing, the more he sees in it; and the investigator who has engaged himself assiduously with one object sees in it a whole world, in the view of which all other things pass from notice. It is a joy to work in this way on one's own field, and it is also necessary for every one to undergo rigorous schooling in such exercises, especially previous to appearing before the world with any general treatise. Tendencies like that of contemporary science toward specializing are naturally inevitable. The time will come again in which the pressure will in like manner impel students, sifting out the now concluded results of science, to work them up into a whole.

It is, however, not doubtful that the majority of students, so far at least as they are public teachers, to-day go too far in their specializing. Whoever uninterruptedly looks upon a single thing year after year learns no more of the whole. Not alone that the view over science is wholly lost to him, but even in his own branch is such a man at last no longer able to be at home. It is almost the fashion to-day, as among the zoölogists and botanists, for example, no longer to make themselves acquainted with entire animals and plants. At all events, many zoölogists of the day—and the same is the case with the botanists in their sphere—have hardly ever accurately examined an animal as a whole; but they have with the microtome dissected ever so many animals of a group into fine slits, have pulled them to pieces with the needle under the microscope, and have described their observations in monographs. Every one who has done this kind of work in any considerable degree, as has the present writer, must know that while it is going on there is not much time left for the learning of other things. I will not go too deeply into the merits of the work in itself—it must be done. But I hold that in the immediate present it has become too exclusively predominant.

Hand-in-hand with the exaggeration of special work goes the growing inability to write understandingly to the general public. The German student appears only too often to think that he must present his subject in the most difficult phraseology, excessively interlarded with strange words, as if he purposely would permit a glance into the treasures of his science and his knowledge only to an extremely narrow circle. Nothing better shows this than the style of most of our (German) text-books when compared with that of the majority of the English books, which nevertheless are not behind ours in thoroughness. Even once to write something "popular"—who does not know how many of our students look loftily down upon this art? Now I think it is a valuable art, and worthy of recognition. It can not be expected that every one shall become possessed of it, and every one shall exercise it; but the art is very often wanting simply because exclusive devotion to "purely scientific" work in some extremely narrow field of knowledge has prevented its ever having been put in practice. Many also deliberately hold themselves aloof from it because whoever among us writes understandingly to the public appears to compromise his reputation as a man of science.

Why is it entirely different in England? Why do the first men of science there—those who are recognized and admired by the German scientific world—write understandingly to every one? Who does not enjoy the famous essays of Faraday on "A Candle," of Tyndall on "The Forms of Water," of Huxley on "The Crayfish," etc.? I do not forget that there are also a few scientific men having this talent among us, but they do not escape the shrugs of their contemporaries. It is true that a student who should make such general representation his principal work would soon forfeit his importance as an investigator. But it is also desirable, on the other hand, that the naturalist should not exhaust himself in the examination of details, but that he should, for the sake of keeping himself fresh, come forward with his conclusions from time to time immediately before the cultivated world, and not let the great value of his investigations be recognized by strangers only. In sequence with this general reserve of students—besides the resulting deficiencies in scientific school-instruction—exists also a backwardness among our laymen in expressing themselves respecting their observations of Nature. Nature invites every one to observation and reflection; and even the inexpert inquirer is not excluded from the privilege of being led up to the noblest experiences through this observation and reflection. What does not scientific zoölogy, to mention but one example, owe to the bee-master, Pastor Dzierzon, for his determination of the parthogenesis of bees? And did not Goethe, without being a professional naturalist, arrive at his famous fruitful ideas of the composition of the skull out of vertebræ, of the human intermaxillary, and of the tracing of the parts of the plant back to the leaf? He repeatedly expresses in plain terms the thought of the unity of all Nature and of the continuous development of her forms, on grounds not of pure speculation, but of observation and reflection upon it. Darwin's corresponding conclusions also originated from the simplest observations that presupposed no scientific

character, and were open to be made, with a little tact, by every sharp eye and clear head. The English can also furnish us with the model for this participation of unprofessional persons in the observation of Nature. Not only their many colonies, their residencies, and their domains, in the farthest parts of the globe, permit individuals to make numerous new and valuable observations, but there are also in England numbers of wealthy persons who, having no official positions, are animated by a spontaneous scientific enthusiasm, and are able to come forth again and again as patrons of scientific researches. Thus the gap between amateurs and professionals in the sciences is necessarily becoming narrower. The closer relation of the world of students to the public must, on the other side, give heart to the individual—yes, raise up a positive desire in him to make known what he has observed, and inspire him to experiments of his own. Community in work of this kind can already show its results. A perusal of the journal "Nature," in which students and laymen publish their researches and observations from the fields of science in all the five quarters of the globe, wherever Englishmen dwell, will illustrate this in the plainest manner. Inquiry is active, then, and is stimulated by the constant contribution of new facts. The most distinguished men of science are not ashamed to take part in these proceedings; but their communications give the nation opportunity to become immediately acquainted with their researches, to estimate their value, and rejoice over the good that accrues to the nation from them. In Germany such a usage could, in consequence of the closer relations of the different members of society, be made to be of much wider significance than in England.
—*Translated for the Popular Science Monthly from "Humboldt."*

FOOD AND FIBER PLANTS OF THE NORTH AMERICAN INDIANS.

By J. S. NEWBERRY.

It has happened to me to visit nearly forty tribes of the native population of North America, and many of these at a time when they had had little or no intercourse with the whites. As a physician and botanist, my attention was naturally directed to the use of plants among them for food, and as remedies. I made many notes on these subjects, and, as they have never been published, and contain some items that may be interesting, it has seemed to me worth while to put them on record. Most of the observations to which I have referred were made a quarter of a century ago among the Indians of the Far West, remote from civilization, and where they were living in the "state of nature." The plants, of which the Indians I have visited have made use, are the following:

1. Maize (*Zea mais*), our Indian corn, seems to have been the most widely diffused and most important of all the kinds of vegetable food employed by the native population. In all parts of North and South America, where the climate was favorable, the whites found corn cultivated by the aborigines, and in the tombs of Peru as well as in the mounds of the mound-builders, ears of corn have been discovered, which prove that it was an important element of subsistence as far back as human records extend. Even the nomadic Indians who inhabited the forest-covered region between the Mississippi and Atlantic had their corn-fields and their patches of beans and squashes, and succotash (the Indian name) was the dish most esteemed in their *cuisine*, and is almost the only one which has been adopted by the whites.

In the region west of the Mississippi only a limited district is adapted to the cultivation of maize. It is a plant which finishes its growth and ripens its seed within three or four months, and it therefore matures within the tropical summer which prevails even to the northern boundary of the United States. But it requires both warmth and moisture; hence in the dry regions of the Far West it can only be cultivated in few localities, and there attains but imperfect development. In California, where so many fruits, flowers, and grains reach unequaled perfection, the cultivation of corn is rarely successful. Even where irrigation supplies the necessary moisture and the mid-day sun is hotter than in any Eastern State, the cloudless sky permits such rapid radiation that the nights are always cool, often cold, and the warm, moist nights of midsummer in the Mississippi Valley, when the corn may be heard to grow, never occur. On the table-lands of Arizona, New Mexico, and Mexico corn is quite extensively cultivated, but under difficulties, and never with what we should call success. The plant is always small, the grain light in texture and usually of some fancy color, and it is not uncommon to see the bread or cakes baked from it of a positive blue. Among the Moquis of Northeastern Arizona, where the plains that are cultivated are sandy, the seed-corn is dropped to the bottom of holes twelve to fifteen inches deep, made with a stick. Though dry at the surface, the sand is moist below, having absorbed all the water furnished by the snows of winter, and the cloudless sun warms the soil so that the grains germinate even at that depth. When the growing plant rises above the surface of the ground it immediately shoots out its ears, and the field when the crops mature looks as though it had been inundated and sand deposited around the stems to half their height. The color of the grain is usually blue, and the bread made from it and baked between two flat, smooth stones by the Moquis, though well flavored, looks like blue wrapping-paper.

2. Beans (*Phaseolus vulgaris*). It has been demonstrated that one or several kinds of beans were generally cultivated in America at the time of the discovery by Columbus. The "Lima-bean" was certainly

unknown in Europe before it was received from America, and that is probably true of other varieties. Among the Pueblo Indians of the table-lands, and the Mohaves on the Colorado, we found many different kinds of beans in cultivation. Some of these were of excellent quality, more delicate in texture and flavor than any cultivated by the whites.

Among the Mexicans and the inhabitants of our Territories bordering on Mexico the *frijole* is the most important article of diet, and in all campaigns and exploring expeditions in the West our people have come to consider beans as the most useful element in the commissary department. In making forced marches where the least possible weight could be carried, two articles of food were chosen in preference to all others, viz., beans and coffee ; if only one could be taken, that was always the bean, which possesses more and more varied nutritious elements than any other fruit or seed cultivated by man.

3. *Psoralea esculenta* (*pomme blanche*). The root of this leguminous plant has been for centuries an article of food among the Indians inhabiting the Rocky Mountains and the plains bordering them. It is frequently referred to by the earlier travelers in that region, and was sometimes their main subsistence during the intervals when for any reason game was not to be had, and transported supplies had been exhausted. The root is white and farinaceous, but has a negative flavor, and as it nowhere exists in great quantity, it has been rather a make-shift than a staple, and its use has been abandoned wherever the supplies furnished by the white man have been attainable. The plant is about a foot high, with hairy stems and leaves, and with compact spikes, of bluish-white flowers. The root is tuberous, an inch or more in diameter, white, farinaceous, and wholesome.

4. *Camassia esculenta* (*camass*). Over all the country drained by the Columbia River, and especially the plains and mountain valleys about its sources, the camass grows in considerable abundance, and it has been not only a common resource for the Indians inhabiting that region, but certain localities where it is found in large quantities have taken their names from it, and they are places of resort for the purpose of gathering it. One of these is the somewhat noted Camass prairie on the line of travel from the Upper Missouri to the Columbia. The plant is liliacious, has linear leaves, a scape usually twelve to eighteen inches in height, bearing pretty blue or white flowers. The bulb is about an inch in diameter, mucilaginous, sweetish, and quite nutritious. Where it abounds it is gathered in large quantities, baked, and stored for winter use.

5. *Peucedanum farinosum* (biscuit-root, couse). In the country bordering the Columbia and in Northern California there are many plants which belong to the umbelliferous genus *Peucedanum*, some with yellow and a few with white flowers. The foliage is much dissected, sometimes capillary like that of the fennel. Among these is

one which has a round or oblong, white, farinaceous root somewhat like a small parsnip. It is called couse, or biscuit-root, by the Oregon Indians, and is quite an important source of food among them. It is gathered and dried for winter use, is then ground between stones to a kind of flour, and of this a palatable and nutritious cake is made. It is also sometimes boiled with meat.

6. *Apios tuberosa* (ground-nut). In all the United States on or east of the Mississippi the twining stem and purple flowers of the ground-nut are well known to the country boys, for they have learned that at the base of that stem are tubers which may be eaten and with a little make-believe enjoyed. These tubers were quite as well known to the aboriginal inhabitants, and to them they were a more important article of food. They are, however, small, somewhat woody, and in all respects inferior to the potato, which superseded them wherever attainable.

7. *Helianthus tuberosus* (Jerusalem artichoke). This plant is usually supposed to have been introduced from Europe, but Dr. Gray has given good reasons for believing that it is a native of this country, and that its tubers were used by the Indians of the Mississippi Valley for food. It has been said to be a variety of *H. doronicoides*, but is probably a form of *H. giganteus*.

8. *Helianthus annuus* (sunflower). In the central part of the continent—Colorado, Utah, Idaho, and Wyoming—are large areas of open ground which sustain a vigorous growth of the sunflower. It is always an evidence of good soil where it grows, and the magnitude of the stem, which is often six or seven feet high, and the flowers four to five inches broad, measures the richness of that soil. Nowhere in nature do the flowers become so large and the seeds so abundant as in the cultivated variety, but the seeds have long been used for food by the Indians, and it is probable that the plant grew larger about their villages than we now find it in the dry and comparatively sterile regions of the Far West. The Indians use the seeds for food, and sometimes extract an oil from them which is employed for the hair, or to lubricate or paint the face or body.

9. *Wyethia robusta* (Nutt.). In Oregon and Northern California I found the Indians gathering the seeds of a species of *Wyethia*, which Dr. Gray considers that described by Nuttall. On the east side of the Sierra Nevada, several species of the genus are very widely distributed, the larger ones having flowers which resemble those of *Inula*, and in many dry regions for a brief interval in the spring the surface is quite covered with their broad ovate leaves, and the scene made brilliant by their showy golden flowers. Their glory is, however, short-lived, for early in the summer the flowers disappear, the leaves become dry and brown, and rustle under the feet like those which fall from the trees in our forests with the autumn frosts. The achenia of *Wyethia* are relatively large, and contain a sufficient amount of

albumen to afford considerable nutrition, but the chaff is quite in excess of the kernel, and, when bruised together in their rude mortars, the Indians are compelled to gorge quantities of the material to satisfy their hunger. It is poor food at best, but is a welcome resort when, as it often happens, they are on the verge of starvation.

10. Nut-Pines.—In various parts of the Far West grow species of *Pinus* in which the seeds are of unusual size. The primary object of this is undoubtedly to furnish an adequate amount of prepared food to the germinating plant in regions where the struggle for existence is desperate, not with competing forms of vegetable life, but against the sterility of the soil or the severity of the climate. Incidentally this provision of Nature is of great benefit to a variety of animals, and even to man himself. It is evident that this special device for securing the perpetuation of the species is vicarious with the development of the wing upon the seed by which it is caught in the wind and its distribution favored. Where the seed is unusually large and heavy the samara can do little for its transportation, and where it is largest the wing is reduced to a simple raphe, or has entirely disappeared. For the most part these nut-pines are the inhabitants of arid regions where the amount of animal life is small, and therefore there are few enemies by which the seed would be destroyed. And there the sterility is such that any device by which the seed was carried away from the protecting shade and the fertilizing influence of the parent tree would be destructive rather than protective. Hence the seeds are wingless, and are dropped among the decaying leaves that gather under and about it. To the Indians these pine-nuts are in some regions not only an important but almost an indispensable source of subsistence; they gather them systematically, as our farmers harvest their crops, and, in cases where for any reason a failure of this crop occurs, some tribes or bands have been brought nearly or quite to starvation for the want of the nutriment they afford.

The list of the nut-pines of the Far West includes the following species: *Pinus Sabiniana* and *P. Coulteri*, of California; *P. albicaulis* and *P. flexilis*, which grow on the mountains of Oregon, Idaho, Montana, etc.; *P. edulis* and its variety, *P. monophylla*, of the arid districts of Nevada, Utah, Arizona, and New Mexico; and, finally, *P. Parryana* and *P. cembroides*, of Lower California and Northern Mexico. Of these, *P. Sabiniana* has large, ovoid, massive cones, six to eight inches in length and four to six inches in diameter, of which the surface bristles with strong and curved spines. The seeds are as large as good-sized beans, and of much the same form. The tree grows to a moderate or large size, but never forms forests. It is generally found scattered over the rocky foot-hills of the mountains, up to the height of three or four thousand feet—its great spiny cones, its spreading form, and blue-green foliage, making it everywhere conspicuous.

Pinus Coulteri, which in many respects resembles the last, is more southern in its habit, occupying the mountains of California south of San Francisco. The cones are similar to those of *P. Sabiniana*, but much longer, often one foot in length by five or six inches in diameter, and having a conical form. The seeds are large, bean-shaped, and edible. Like those of all the nut-pines they have a strong terebinthine taste when raw, but this disappears when they are roasted, as they generally are by Indians and whites.

By far the most interesting and economically important of the nut-pines is the "Piñon" (*P. edulis*), which inhabits the almost desert portions of the Great Basin of Arizona, New Mexico, and Colorado. In some parts of Nevada and Utah its monophyllous variety occupies, with a sparse and scattered growth, large areas, where it is the only tree, except a bushy cedar (*Juniperus Utahensis*). In Arizona, New Mexico, and Southwestern Colorado, its normal or two-leaved form is everywhere present, sometimes forming what might be called a forest-growth, though the trees are never large nor closely set. In all these regions the wood of the "Piñon" is the chief dependence of the lead-smelters for fuel, since it is quite dense, and, unlike that of any other conifer, furnishes good charcoal. Equally valuable is this tree to the native population, from the subsistence afforded by its nuts. The cones are small and ovoid in form ; the wingless seeds are elliptical in outline, half an inch in length, and very palatable when roasted. The tree is said to fruit abundantly but once in three years ; different colonies, fortunately, having different periods, so that there is no year in which there is entire failure of the crop, except when one of the terrible droughts characteristic of the climate occurs.

At the season of the nut-harvest the natives migrate to the groves of "Piñon," and gather the nuts in large quantities to be stored for future use. They are treasured as their choicest delicacies ; and a handful of pine-nuts is to an Indian child as much of a treat as are sugar-plums to our boys and girls. Some of the Piñon-groves on the flanks of the Sierra de la Plata in Southwestern Colorado have evidently been visited periodically by the Pueblo Indians for ages ; for fragments of their peculiar ornamented pottery cover the ground ; at least every square yard has its potsherd.

The seeds of *Pinus flexilis* and *P. albicaulis* are smaller than those already mentioned, and the trees are more Alpine in habit and scattered : the nuts have, therefore, comparatively little value to the Indians, but they are an all-important source of food to the squirrels which inhabit the regions where they grow.

The more southern nut-pines, *Pinus cembroides* and *P. Parryiana*, are similar in their habit to *P. edulis*, of which they are, indeed, probably varieties. Their seeds, like those of the Piñon, are used by the natives in the same way, and are only less important because the trees are more restricted in their range.

FRUIT OF THE CACTUS.—The prickly pears which grow on so many species of cactus, differ very much among themselves, but quite a large number are edible. The fruit of the giant cactus (*Cereus giganteus*) is in size, consistence, and flavor, somewhat like a fig. The plant sometimes grows to fifty feet in height, and flowers near the summit, and since it can not be climbed on account of the spines by which the trunk is thickly set, it is a matter of no little difficulty to get at the fruit when it ripens. The Indians beat it off with stones, if any chance to be near, and sometimes shoot it off with arrows.

The fruit of many other species of *Cereus* is eaten and is doubtless nutritious, but the flavor is usually insipid, and, however, attractive it may be, in the "eyes" which are scattered over the surface lurk many minute, sharp, and brittle needles, which will penetrate the tongue and lips, and cause great suffering to any one who bites it rashly. The natives are always careful to wipe or brush off these spines before the fruit is either handled or eaten.

The *Opuntias* (*palmate cactus*) include a great number of species differing considerably in size and habit. As among the other kinds of cactus, the fruit is usually brilliantly colored, has a smooth and spiny skin, and pulpy interior thickly set with seeds. Though generally somewhat tasteless, and sometimes having a disagreeable flavor, the fruit of certain species is esteemed by the Mexicans and Indians, and one species at least may be said to be cultivated for its fruit. This is the *Tuna*, the gigantic *Opuntia* of Chihuahua and Sonora. Around the old missions may be seen many of these plants, some of which are so large that the fruit is gathered by the help of ladders! Among all the prickly pears, however, the fruit of the strawberry cactus (*Cereus stramineus*) is the most delicious. It is ovoid in form, as large as the largest strawberry, of similar color and even finer flavor. It grows sparingly in New Mexico and Chihuahua, and the fruit is eagerly sought by men, birds, and insects; so that, being a shy bearer, the supply is decidedly behind the demand.

Dr. V. Harvard, United States Army, who has given us much interesting information in regard to the botany of the region bordering the Rio Grande, mentions several other species of cactus, of which the fruits are edible, viz., *Cereus dasyacanthus*, (Eng.), fruit sub-globose one inch in diameter, green or greenish-purple, when fully ripe delicious to eat, much like a gooseberry; and *Echinocactus longehamatus*, fruit one to two inches long, red, and as delicious as that of the strawberry cactus. Of these I have collected the plants, but have never seen the mature fruit.

Nuphar polysepala (Western water-lily). In Oregon our yellow water-lily (*Nuphar advena*) is represented by a species which resembles it in flower, leaf, and habit, but differs from it in having a larger number of sepals. The seed-pod is also larger, often having the size and form of an egg, and being filled with seeds which are not unlike the grains of our broom-corn. They are well flavored and nutritious, and are locally much used by the Indians for food. One of the Klamath lakes, which is about ten miles in diameter, is very shallow, and a large part of the surface is covered with the leaves of this water-lily. The Indians who live upon the banks of this lake gather the capsules as they mature, and store them for winter use. In some of their wigwams we found as many as twenty or thirty bushels of them at the time of our visit in August. Just how they are used I can not say, but I believe they are either ground to make a kind of coarse flour, or are parched, as the grains of maize so frequently are by the Indians. Perhaps nowhere else does this plant furnish an important food-staple, but for many hundreds of the Klamath Indians it is one of the most valuable of their winter stores.

Acorns.—At least two kinds of oak in California furnish acorns which are used as food by the Indians (*Quercus lobata* and *Quercus agrifolia*). Of these, the first is the largest of Western oaks; it is found in the greatest perfection along the streams in the Sacramento valley, where I have sometimes seen it a hundred feet in height, and covering with its spreading branches a circle more than one hundred feet in diameter. The acorns are long—elliptical in outline, an inch and a half in length by half an inch or more in diameter. The kernel is sometimes rather bitter, but more palatable than that of any of our Eastern oaks, and quite nutritious. In the region where the tree abounds, the Indians in former times were in the habit of collecting acorns in large quantities and storing them for winter, and I have seen nearly a hundred bushels in one wigwam. They are prepared for eating by grinding the kernels to a kind of coarse flour; this is mixed with water to a thick paste; a circular depression with raised edges is made in the sand, into which this paste is poured. A fire is then built over it, and it is half-baked, half-steamed, to the Indian taste. This treatment takes the bitterness from the acorn, and the resulting cake, though according to our notions somewhat lacking in cleanliness, is well-flavored and wholesome.

In Southern California the evergreen-oak (*Q. agrifolia*) grows to be a magnificent tree, but throughout the broad region it inhabits it is more generally a small tree or even a large bush. Its acorns are long and pointed, sometimes quite acute; the kernel is somewhat bitter, but it is often used for food by the Indians who inhabit the more arid portions of the region where it is found, and where the scarcity of subsistence drives them to eat whatever is nutritious and not positively harmful.

The mezquite (*Prosopis glandulosa*) is one of the most wide-spread and useful plants in the southwestern portion of the United States and Northern Mexico. In Texas it is a tree of respectable size, the trunks attaining on the Brazos a diameter of a foot or more, but it is always low and spreading. In the more arid regions it sometimes grows abundantly, but only as a bush. In such cases, however, the roots are of large size, of peculiarly dense texture, and furnish an excellent fuel. The fruit of the mesquite is a yellow, bean-like pod, six to eight inches in length, by one half an inch wide. In this there are numerous hard, dark seeds, and between them a considerable quantity of a yellow, farinaceous substance, sweet and agreeable to the taste. Where the tree abounds these pods are eaten by all herbivorous animals, and in certain localities they serve as subsistence for human beings. In the Mohave Valley, on the Colorado River, we found Indians making considerable use of the fruit of the mesquite for food. The pods were pounded together in a kind of rude mortar, the seeds and husks imperfectly separated, and the farinaceous substance made into a kind of cake. This closely resembled a preparation of yellow corn-meal, and tasted a little like it.

Nelumbium luteum (water-chinquapin). This beautiful plant is found in comparatively few localities, and it therefore can not be regarded as an important source of food-supply; but the filbert-like nuts which are contained in its discoid receptacles, and which have given it its common name, are eatable, and have always been valued by the Indians. The *Nelumbium* is most abundant in the western part of Lake Erie, especially about the mouth of the Maumee River. It also grows on the islands in that lake, in Lake Winnebago, in the Ohio at North Bend, Sodus Bay, New York, Seldon's Cove on the Connecticut, and in the Delaware. In many of these localities it is supposed to have been planted by the Indians. This is the finest of our North American water-lilies, and it may be at once recognized by its large peltate leaves, and its flowers, six inches in diameter, greenish-yellow in color, often with a flush of red.

Our plant is closely allied to *N. speciosum*, which grows spontaneously in India, and, like the papyrus, was formerly cultivated on the Nile, but is not now found in Egypt. This is sometimes called the lotus, but the true lotus was a *Nymphæa* (*N. lotus*), a species very much like our white water-lily (*N. odorota*).*

Wild rice (*Zizania aquatica*). This plant, though very widely

* Both the white water-lily, the true lotus, and a blue one (*Nymphæa cærulea*) grow abundantly in the delta of the Nile, and were highly esteemed by the flower-loving Egyptians. They were used by them to decorate the tables in their feasts, and as crowns and garlands for the guests. They also formed a conspicuous feature in their offerings to the gods, and at funeral ceremonies.

There is considerable difference of opinion among scholars as to the identity of the plant which bore the fruit said by Homer in the "Odyssey" to have been offered to Ulysses in North Africa, and reputed to have the peculiar property of making those who ate of it forget home and country. It certainly was not the Indian nor the Egyptian water-lily, for Herodotus has described them both; but it was probably the fruit of *Ziziphus lotus*, a small tree which grows in Barbary. This is something like a date or plum in appearance, has a delicious flavor, and the Arabian poets ascribe to it a lethal influence similar to that felt by Homer's *lotophagoi*.

distributed, is most abundant in the shallows of our chain of Great Lakes. In some places many thousand acres are occupied by it, and it resembles fields of grain. The stalk is often seven or eight feet in height, projecting four or five feet above the water. In the autumn, when the seeds are ripe, such localities are now thronged with water-fowl, which are very fond of it. In early days, while the Indians were numerous about the Great Lakes, the wild-rice harvest was an important epoch in their year. As usual, the labor of collecting the seed fell to the lot of the women. These, pushing their canoes into the thickest growth, bent the heavily-laden tassels down and beat off the seeds with sticks. In this way their boats were soon loaded, and the grain became their most important resource during the long winter that followed. The shores of the west end of Lake Erie are still occupied by the wild rice, just as in ancient times, for it grows where man can neither cultivate the soil nor navigate the water. Here, where it was gathered in greater quantities than anywhere else by the Indians, it still feeds great flocks of water-fowl, but not a human being. The grain is small, with great difficulty separated from its envelopes—is, in fact, a poor kind of oat, which was superseded by the wheat of the white man in the estimation of the Indian long before he took his departure to the happy hunting-grounds.

Mescal. The different species of *Agave* have played a most important part in the economy of the native population of Northern Mexico and our Southwestern Territories. From them they have obtained food which, though not to our taste, is in their estimation a luxury. They have also distilled from them intoxicating liquors which, for the time being, have made them happier than the food they ate, and from some of the species they have obtained fibers of great strength, of which they have made varied use. At least two species (*A. Parryi* and *A. Palmeri*) are known by the popular name *mescal* among the Indians and Mexicans. Of these the central bud from which the flower-stalk springs is, at certain seasons, charged with a sweet, gummy substance which is prepared beforehand to supply the rapid drain of material in the growth of the flower-scape, flowers, and fruit. When cut out at this time it looks somewhat like a small cabbage; this is roasted in the ashes, and is considered by some of the Indian tribes a great delicacy. It is very sweet, but is a mass of fibers, and I can only compare it to oakum dipped in molasses. Probably its sweetness commends it to those who get very little sugar in other forms. Sometimes this central bud when roasted is distilled, and furnishes a fiery kind of whisky, which is also known as *mescal*.

The maguey, or century-plant (*Agave Americana*), throughout Northern Mexico supplies both fermented and distilled liquors. It is sometimes cultivated for this purpose, but over large districts is so common as to be the most striking feature in the vegetation, and the demand is fully supplied from this spontaneous growth. The Indian name of the liquor made from it is *pulque*, and the establishment where it is distilled is called a *pulqueria*.

Other species of *Agave*, which have narrower and less fleshy leaves, furnish neither food nor drink, but valuable fibers. Of these the most celebrated is the Sisal hemp (*Agave sisalana*), a tropical plant of which the home is in Southern Mexico. It furnishes a fiber similar to the Manila hemp, and of equal value. This plant will grow in Florida, and many years ago Dr. Perrine obtained a grant from the American Government to establish a plantation of it. He was in the full tide of successful experiment when the Seminole War broke out, and his plantation was destroyed by the Indians, from which he with his family made an almost miraculous escape.

Another less known but scarcely less valuable plant belonging to the same genus, is the "lechuguilla" (*Agave heteracantha*) of Chihuahua and the surrounding country. Of this the leaves are from a foot to eighteen inches in length, and grow in a tuft like those of the century-plant. Though separated with some difficulty from the parenchyma in which they are enveloped, the fibers that traverse the leaves are numerous and very strong and are largely used by the Mexicans for the manufacture of ropes, sacking, etc. When the proper machinery shall be invented for treating the plant, it is probable that this fiber will become an important article of commerce.

Though less valuable, the fibers contained in the leaves of the large species of yucca (*Yucca baccata*), which abounds in the same region with the lechuguilla, are, to some extent, utilized in the same way.

Among the fiber-plants used by the Indians I should mention one lichen (*Evernia sarmentosa*) which, though of little importance, is interesting as the only plant of this group, so far as I know, serving any useful purpose among the Indians. In certain localities among the mountains of Oregon the fir-forests are draped with the gray fiber of the *Evernia*, which there has much the aspect of the Spanish moss as it hangs from the live-oaks in our Southern States. In a few instances I have seen this fiber utilized by the Indian women, who twist it into rolls as large as the little finger, and then sew these together to make a kind of jacket similar to that which they much more frequently form of strips of rabbit-skin. These garments are not handsome, but are thick and warm, and do much to protect the wearers from the severity of the winter in the Northwest.

The Sotol (*Dasylirion Texanum*). In Southwestern Texas and in Chihuahua one of the most common and striking plants is the *sotol*, as it is called by the Mexicans. In its general habit it resembles the yuccas. Usually the trunk is very short, scarcely rising above the ground, and from its summit radiate a large number of linear leaves, which are about three feet in length by two inches wide at the base, tapering to a fine and flexible point. The sides are armed with strong recurved hooks, which make it very unpleasant to handle, and even to touch. In the regions where it abounds the hemispheres formed by the radiating leaves—four or five feet in diameter and height—are conspicuous objects in the scenery over thousands of square miles; from which it will be seen that the supply of material afforded by this plant is practically inexhaustible. The part which is used is the summit of the trunk, composed of the closely imbricated and thickened bases of the leaves. This is an ovoid mass from six inches to one foot in diameter, which at all times, and particularly before the period of florescence, contains a large amount of farinaceous and saccharine matter. When fresh it is tender and well flavored, and in that form would keep one from starvation; but, when roasted, it is much better, and constitutes an excellent and delicate vegetable. In traveling through that country I have made a lunch on a fraction of one of these roasted heads with great satisfaction to myself. It is, however, not used for food, except in emergencies. The Comanches and Lipans, the aboriginal inhabitants of this region, when pursued, found an unfailing resource in the sotol, and it is certainly impossible to starve those who have access to it. The most important use made of the sotol is to manufacture from it a kind of whisky, which is known as *mescal*, but is quite different from the other kinds. This liquor is made in a very simple way. A small still is taken to some spring or water-course where the sotol abounds, and there rudely set up; the plant is then collected by cutting off the leaves with a *machete*, leaving a cabbage-like head. This is severed from the root, loaded onto donkeys, and brought to the *vinata*, or distillery, where it is roasted. This is effected in a pit four or five feet deep and ten or twelve feet in diameter, lined with blocks of stone at the sides and bottom. Fuel is heaped into this pit and fired; when the fire is burned out the pit is filled with the heads of sotol. In the course of a few hours they are somewhat irregularly roasted and steamed; they are then taken out, chopped in small pieces, thrown into vats, and allowed to reach vinous fermentation. The liquid extracted from the pomace is then distilled, making a white, peculiarly-flavored, but not disagreeable spirit, that is largely used in this region. Though less highly esteemed than the more carefully-made mescal distilled from the maguey, it is preferred to the whiskies made from corn or rye, and it is certainly much less injurious. It is reported that delirium tremens is unknown in the country where it is most used, and I saw among the people none of the usual effects of alcoholism either in their persons or manners. The country where the sotol abounds is capable of furnishing an unlimited quantity of alcohol, and it might, therefore, replace the grains which are sacrificed to its manufacture in the United States.

Soap-Plants.—*Chlorogalum pomeridianum* (Amole). In the valleys of California grows a tall, slender-stemmed liliaceous plant, with purple and white flowers, which played an important part in the economy of the Spanish population, and is still more or less used by the country people. It is the well-known Amole, or soap-plant. It rises from a subterranean bulb, which is egg-shaped in form, two or three inches in diameter, and enveloped in a thick coating of black, matted, hair-like fibers. This bulb has the detergent properties of soap, cleaning the hands or clothing quite as well as and much more pleasantly than the coarser kinds of soap.

In Mexico and our Southwestern Territories there are several other soap-plants, of which the narrow-leaved yucca (*Y. angustifolia*) is the most famous, because of its wider distribution rather than its greater efficiency. Aside from baser uses it is generally employed by the Mexican women to wash their luxuriant and lustrous hair, of which the beauty is said to be largely due to this practice. The leaf pulp and the roots of the larger yucca (*Y. baccata*) have the same properties though to a less degree; but the most effective soap-plant of this region is the lechuguilla, of which the parenchyma of the leaves is thought by the inhabitants of the country where it grows to be better than the best soap for washing, and it is claimed that this portion of the leaf if dried and powdered may be made as useful an article of export as the fibers.

Still another and very different soap-plant is found in Texas and Mexico, the (soap-berry) *Sapindus marginatus* (Wild.). This is a tree twenty or thirty feet in height, which bears a multitude of whitish berries as large as small cherries, and which have a very mild and yet efficient detergent property.

BERRIES.—The Indians are great berry-eaters. During the summer the huckleberries, strawberries, blackberries, etc., contributed largely to the subsistence of the Indians who formerly lived in the Mississippi Valley and the Eastern States; and when the white population increased, and villages and towns came near enough to offer markets, the women depended largely upon their baskets of berries for the purchase of the muslin, calico, blankets, and trinkets that soon became necessary for their happiness.

In the Far West berries are a much more important element in the commissary of the Indians, probably because they are produced there in an abundance and variety unknown in any other part of the world. The service-berry (*Amelanchier Canadensis*) grows throughout nearly the entire wooded region west of the Mississippi, not as a tree, but as a shrub, which forms tufts or thickets that in some regions become storehouses of delicious food. The berry is black when ripe, ovoid in form, and often half an inch in length. It is very sweet, palatable, and nutritious, and no one need starve or suffer from hunger where it is plentiful. In places it covers mountain-slopes continuously for miles, and I have there seen thousands of acres thickly set with bushes six or eight feet high, fairly bending under the weight of fruit, which was drying up and decaying because there seemed neither insect, bird, animal, nor man to eat it.

In a great number of localities service-berries are stored for winter use by the Indians. They are gathered where most abundant, crushed and made into a paste which is spread out on bark or stones in the sun until it is thoroughly dried. It is then put in sacks, and during the winter serves to give variety to their diet which otherwise consists of flesh or dried fish.

Huckleberries.—As formerly among the Eastern Indians, so now among those of the Far West the huckleberry is not only a luxury but almost a necessity. The species in the two districts are not the same: in the East the high and low blueberries (*Vaccinium corymbosum* and *V. Pennsylvanicum*), and the black huckleberry (*Gaylussacia resinosa*), are the most useful kinds. In the West are many species, but only two which have economic importance. Of these, one is small, and resembles our *V. Pennsylvanicum*, but has a berry covered with bloom of a very pronounced blue color; the juice is very red and somewhat acid. This covers glades on the slopes of the Cascade Mountains, Oregon, and the fruit is so abundant as to give a bluish color to the whole suface; this I suppose to be *V. occidentalis* of Gray. Another species, which does not correspond to any description yet written, but may be a form of *V. Myrtillus*, surpasses in the excellence and abundance of its fruit any other huckleberry of which I have knowledge. It covers great areas on the flanks of the Cascade Mountains, in Oregon, where the forest has been burned off; growing two to four feet in height, and standing close on the ground; sometimes really bending under its load of berries. These are round, half an inch in diameter, of light wine-color, and of a delicious vinous flavor. So abundant is this fruit that, sitting down in a clump of these bushes, I have filled a quart cup without changing my position. The Indians make long journeys to the localities where these berries are most abundant and gather and dry them for winter use. The drying is rapidly effected by burning one of the great fir-trees which, killed by fire, have been subsequently prostrated by the wind and now lie thickly strewed over the open surfaces where the berries grow. When this is well burned and affords a steady heat, flat stones, if they can be found, are covered with crushed berries and set up before the fire where the drying is soon effected.

Several other berries that abound in the country bordering the Columbia are gathered and stored much in the same way. Of these, that which after the huckleberries and service-berries is most used is the salal (*Gaultheria shallon*). This plant is as unlike our Eastern wintergreen (*G. procumbens*), or the closely allied but acaulescent species of Oregon (*G. myrsinites*), as can well be imagined. It is a decumbent shrub, of which the stem is one to two feet long, the large ovate alternate leaves so thickly set as almost to touch their edges, and hanging below are a considerable number of black, pedunculate berries, growing in the axils of the leaves. These are larger and longer than those of our wintergreen, are less aromatic, but well flavored. As the plant which bears them grows in the wooded districts so thickly set as almost to cover the ground, the quantity of fruit is very large, and it therefore becomes an important source of food to the Indians.

The small cranberry (*Vaccinium oxycoccus*), is found in the bogs of Oregon as well as those of Maine, and probably stretches quite across the continent. It is used by the Indians, but is nowhere abundant, and is therefore of little value to them.

One of the most noted fruits gathered by the Indians in the Northwest is the salmon-berry (*Rubus spectabilis*). The bush grows to the height of eight or ten feet, has handsome foliage, showy flowers, and a pinkish-yellow berry an inch in length, which resembles our Antwerp raspberry. It is wholesome and nutritious, and is largely used by both Indians and whites, but the taste is rather insipid, and it hardly justifies the promise of its beautiful appearance.

The Oregon grape—the fruit of two species of *Berberis* (*B. aquifolium* and *B. pinnata*)—affords agreeable variety to the diet of the Indians of the Northwest, and is sometimes eaten by the whites. The pretty yellow flowers, for which these plants are sometimes cultivated, are followed by clusters of deep-blue, bloom-covered berries which have a sharp yet pleasant acid taste ; but they are small, and the quantity attainable in any locality is not large.

Throughout all the Rocky Mountain region the red-berried elder (*Sambucus racemosa*) grows as in the Eastern States and Europe, and makes its display of showy but useless berries. There, however, another species of the genus (*S. glauca*) has taken the place of the common elder (*S. Canadensis*) of the Eastern States. It is a larger plant than ours, and is sometimes loaded with black but very glaucous fruit, which is rather better than the fruit of *S. Canadensis* and is more used.

The buffalo-berry (*Shepherdia argentea*). Along the tributaries of the Missouri in Montana, of the Colorado in Utah, and San Juan in New Mexico, and in many other places throughout the Far West, may be found thickets of a somewhat spiny shrub ten to fifteen feet in height with peculiar glaucous, narrow, elliptical leaves resembling those of the olive. This shrub in July and August is sometimes loaded with bright-red pellucid berries which have the acidity and flavor of the red currant. These berries are much used and highly esteemed by the Indians and whites, affording a most agreeable change from ordinary camp-fare, and, by their acidity, supplying a physiological want to the system.

Another closely allied plant (*Eleganus argentea*), and more eastern in its habits, has a larger and edible though drier and less esteemed berry. Both these are close relatives of *Shepherdia Canadensis*, which grows throughout the Northern United States from New England to

Washington Territory, but which is a smaller and useless plant, easily distinguished by its ferruginous, scurfy leaves.

Gooseberries and Currants.—In the valley of the Mississippi and in the mountains of the Far West, a large number of species of *Ribes* are found which, for the most part would be called gooseberries, but among them at least one should be considered as a currant. Some of these plants are showy and interesting, but they are of very little utility. Several of them fruit abundantly, but the berries are insipid or even disagreeable to the taste. In the drier portions of Oregon and Northern California a species of *Ribes* is very abundant and a noticeable feature in the vegetation. It forms tufts or thickets which in the late summer are loaded with red and attractive fruit, but it is only a disappointment, the flavor being flat and insipid, so that it is never eaten by man. In the mountains of Utah I have seen a large and strong species bearing in great abundance a nearly smooth, purplish-brown berry. No small fruit could be more inviting, but it is never eaten; the taste is disagreeable, and the inhabitants have a conviction that it is poisonous.

Nuts.—The Indians of the Eastern States valued more highly, and gathered more abundantly than the whites have since done, the chestnuts, hickory-nuts, walnuts, and butternuts that are here so abundant. For these the Western Indians are compelled to content themselves with acorns and pine-nuts, for there are no chestnut nor hickory trees in all the Western country. The only nuts, indeed, to be found there are the chinquapin of Oregon (*Castanopsis chrysophylla*) and the *nogal* of Arizona, New Mexico, and Texas (*Juglans rupestris*), the latter a perfect "black walnut," but not larger than a boy's marble.

Pine-Bark.—One article of subsistence sometimes employed by the Indians is only resorted to when they are driven to great straits by hunger. Around many of the watering-places in the pine-forests of Oregon and California the trees of *Pinus ponderosa* may be seen stripped of their bark for a space of three or four feet near the base of the trunk. This has been accomplished by cutting with a hatchet a line around the tree as high up as one could conveniently reach, and another lower down, so that the bark, severed above and below, could be removed in strips. At certain seasons of the year a mucilaginous film (the liburnum) separates the bark from the wood of the trunk. Part of this film adheres to each surface and may be scraped off. The resulting mixture of mucilage-cells and half-formed wood is nutritious and not unpalatable, so that, as a last resort, it may be used as a defense against starvation. The frequency with which signs of its having been resorted to are met with is a striking indication of the uncertainties and irregularities of the supply department among savages.

SCIENCE AND REVELATION.*

By Professor G. G. STOKES, P. R. S.

ON the present anniversary, which is the conclusion of my first year of office as President of this Institute, I propose to address a few words to you bearing on the object of the Institute, and on the spirit in which, as I conceive, that object is best carried out.

The highest aim of physical science is, as far as may be possible, to refer observed phenomena to their proximate causes. I by no means say that this is the immediate, or even necessarily the ultimate, object of every physical investigation. Sometimes our object is to investigate facts, or to co-ordinate known facts, and endeavor to discover empirical laws. These are useful as far as they go, and *may* ultimately lead to the formation of theories which in the end so stand the test of what I may call cross-examination by Nature, that we become impressed with the conviction of their truth. Sometimes our object is the determination of numerical constants, with a view, it may be, to the practical application of science to the wants of life.

To illustrate what I am saying, allow me to refer to a very familiar example. From the earliest ages men must have observed the heavenly bodies. The great bulk of those brilliant points with which at night the sky is spangled when clouds permit of their being seen, retain the same relative positions night after night and year after year. But a few among them are seen to change their places relatively to the rest and to one another. The fact of this change is embodied in the very name, planet, by which these bodies are designated. I shall say nothing here about the establishment of the Copernican system : I shall assume that as known and admitted. The careful observations of astronomers on the apparent places, from time to time, of these wandering bodies among the fixed stars supplied us, in the first instance, with a wide basis of isolated facts. After a vast amount of labor, Kepler at last succeeded in discovering the three famous laws which go by his name . Here, then, we have the second stage ; the vast assemblage of isolated facts are co-ordinated, and embraced in a few simple laws. As yet, however, we can not say that the idea of causation has entered in. But now Newton arises, and shows that the very same property of matter which causes an apple to fall to the earth, which causes our own bodies to press on the earth on which we stand, suffices to account for those laws which Kepler discovered—nay, more, those laws themselves are only very approximately true ; and, when we consider the places of the planets, at times separated by a considerable interval, we are obliged to suppose that the elements of

* Presidential address delivered at the annual meeting of the Victoria Institute, on Tuesday, July 19, 1887.

their orbits have slowly undergone slight changes. But the simple law of universal gravitation, combined, of course, with the laws of motion, not only leads to Kepler's laws as a very close approximation to the actual motions, but also accounts for those slight changes which have just been mentioned as necessary to make Kepler's laws fit observation exactly. We are inevitably led to regard the attraction of gravitation as the *cause* which keeps the planets in their orbits.

But it may be said, What is the difference in the two cases? Is not the law of gravitation merely a simpler mode of expressing the observed facts of the planetary motions just like the somewhat less simple laws of Kepler? What right have we to introduce the idea of causation in the one case more than in the other?

The answer to this appears to be that in the one case, that of Kepler's laws, supposing them to be true, we have merely a statement of what, on that supposition, would be a fact regarding the motions of the planets, whereas in the other case the observed motions are referred to a property of matter of the operation of which in other and perfectly different phenomena we have independent evidence.

I have purposely omitted to mention the important difference between the two cases, which lies in the circumstance that Kepler's laws require correction to make them applicable to long intervals of time, whereas the law of gravitation shows no sign of failure; because, even if the former had been perfectly exact, however long the interval of time to which they were applied, I doubt if they would have carried with them the idea of causation.

To take another simple illustration, let us think of the propulsion of a bullet in an air-gun. We speak of the motion of the bullet as being *caused* by the elasticity of the compressed air. And the idea of causation comes in because we refer this particular instance of motion to a property of gas, of the existence and operation of which we have evidence in perfectly independent phenomena.

It is thus that in scientific investigation we endeavor to ascend from observed phenomena to their proximate causes; but, when we have arrived at these, the question presents itself, Can we in a similar manner regard these causes in turn as themselves the consequences of some cause stretching still further back in the chain of causation? If the motion of the bullet in an air-gun be caused by the elasticity of the compressed air, can we account for the elasticity of a gas? If the retention of the planets in their orbits be due to the attraction of gravitation, can we explain how it is that two material bodies should attract one another across the intervening space?

Till a time well on in the present century, we could only take the elasticity of gases as a fact, and deduce the consequences which flow from it. But the researches of Joule and Clausius and Maxwell and Crookes and others have accumulated so much evidence in favor of the general truth of the kinetic theory of gases, that we are now disposed not to rest in the elasticity of gases as an ultimate property beyond which we can not go, but to regard it as itself a consequence of the molecular constitution of bodies, and of the motions and mutual collisions of the ultimate molecules of a gas. Respecting the attraction of gravitation we have not at present made a similar advance. Speculations, indeed, have not been wanting on the part of those who have endeavored to account for it. But none of these so fits into the known phenomena of Nature as to carry with it a conviction of its truth. Yet there is one indication that though we can not at present explain the cause of gravitation, yet it *may* be explicable by what are called second causes. The mass of a body is measured by its inertia; and, though we commonly think of a body of large mass as being heavy, and though we compare the masses of two bodies most easily and accurately through the intervention of weight, yet the idea of mass may be acquired, and means might easily be suggested by which the ratio of the masses of two bodies might be experimentally determined, without having recourse to gravitation at all. Now, according to the law of gravitation, the force with which a given body attracts another at a given distance is strictly proportional to the mass of the latter. If we suppose the attracting body to be the earth, and the attracted bodies to be in one case a brass weight, and in the other a piece of marble, it follows that if they make equilibrium when placed in the pans of a true balance—I make abstraction of the effect of the buoyancy of the air—their masses are strictly equal, and, accordingly, that weight is a true measure of mass. But there is no reason *a priori*, so far as with our present knowledge we can see, why this should be so. We know that if the bodies in the scale-pans were formed, one of brass and the other of iron, and there were a magnet concealed under the table on which the operator placed his balance, the masses would not be equal when there was equilibrium. But that the law is true, and that, accordingly, weight is a true measure of mass, follows with the highest probability from the third of Kepler's laws, and was proved experimentally by Newton, by experiments with pendulums. Newton's experiment has since been repeated by Bessel, with all the refinements of modern appliances, with the result that, so far as the most exact experiments enable us to decide, the law is strictly true. This is perhaps the only instance, as Sir William Thomson remarked to me in conversation, in which there is an exact agreement between two quantities, and yet we are unable to give any reason why they should agree. That such is the case, holds out some prospect of scientific men being able some day to explain gravitation itself—that is, to explain it as the result of some still higher law.

Such is the nature of our progress in scientific investigation. We collect facts; we endeavor to co-ordinate them and ascertain the laws which bind them together; we endeavor to refer these laws to their proximate causes, and to proceed step by step upward in the chain of causation. Presently we arrive at a stage at which, even after long trial, we do not see our way to going further. Yet we are not able to demonstrate that further progress in the same direction—that is, along the chain of secondary causation—is impossible. Science conducts us to a void which she can not fill.

It is on other grounds that we are led to believe in a Being who is the Author of Nature. A conclusion so important to mankind in general is not left to be established as the result of investigations which few have the leisure and ability to carry out. Doubtless, where it is accepted, the study of science enlarges our ideas respecting the greatness of that Being, and tends to keep in check notions of too anthropomorphic a character which we might form concerning him. Still, the subject-matter of scientific study is not, at least directly, theistic, and there have not been wanting a few instances of eminent scientists who not merely rejected Christianity, but apparently did not even believe in the being of a God.

The religious man, on the other hand, who knows little or nothing of science, is in the habit of contemplating the order of Nature not merely as the work of God, but in very great measure as his *direct* work. Of course, the concerns of every-day life present innumerable instances of the sequence of cause and effect; and few are now so ignorant of the very elements of science as not to allow that the sequence of day and night, of summer and winter, is proximately due to the rotation of the earth about its axis, and the oblique position of that axis with reference to the plane of the earth's orbit. But when we get beyond the region of what is familiarly known, still more when we get outside the limits of well-ascertained scientific conclusions, and enter a region which is still debatable ground, where men of science are attempting to push forward, and are framing hypotheses with a view to the ultimate establishment of a theory in case those hypotheses should stand the test of thorough examination—when, I say, we get into this region, a man such as I have supposed may feel as if the scientists who were attempting to explore it were treading on holy ground; he may mentally charge them with irreverence; perhaps he may openly speak of them in a manner which implies that he attributes to them an intention to oppose revealed religion.

To take a particular example. I can imagine that a man such as I have supposed may have always been in the habit of regarding each one of the thousands and tens of thousands of species into which naturalists have divided the animal and vegetable kingdoms as having originated in an independent creative act; that the supposition may have become entwined among his religious beliefs. Such a man would be apprehensive of any attempt to introduce second causes in explanation of the observed fact of the great multiplicity of species.

Akin to the feeling which I have attempted to describe is another, against which we must be on our guard. The religious man is strongly impressed with the truth of certain things which lie outside the discoveries of reason or the investigations of science, and which bear on the whole conduct of his life here, and on his hopes regarding life hereafter. He believes these truths to be divine, and, accordingly, that no legitimate deduction of human reason is liable to come in conflict with them. But the precise mode in which a conviction of the truth of these things was arrived at depends, to a considerable extent, on each man's idiosyncrasy. His natural bent of mind, his early training, his later associations, have all a good deal to do with it. Divine truth is one thing ; our own apprehension of it, and the steps by which in our own minds it has been arrived at, are another. These are liable to human imperfection, and we may not attribute to them the infallibility which belongs to that which is divine. We are not to confound the scaffolding with the building ; nor, if we are anxious for the safety of the edifice, need we therefore fear that, if the scaffolding were tampered with, the whole might come tumbling down, nor should we regard as a dynamiter a fellow-workman who would remove a pole or two.

That truth must be self-consistent, come from where it may, is an axiom which nobody would dispute ; the only question can be, What is truth ? Now, there are truths which we know by intuition, such as the axioms of mathematics ; and there are others, again, which, though we do not perceive them by intuition, yet demonstrably follow from what we do so perceive ; such, for example, are the propositions of mathematics. Then there are other conclusions which we accept as the result of the application of our reason to a study of Nature. Here the evidence is not demonstrative, and the conclusion may have all degrees of support, from such overwhelming evidence as that on which we accept universal gravitation, to what hardly raises the conclusion above the rank of a conjecture. On the other hand, there are conclusions which we accept on totally different grounds ; namely, because we think that they have been revealed. Why we accept a revelation at all, is a very wide question which I can not here enter into. That we do accept it is implied in the membership of this Institute. But, granting the acceptance of revelation, the question remains, What and how much is involved in revelation ? That is a question respecting which there are differences of opinion among those who frankly accept a revelation, and with it the supernatural.

Now, the primary object of the establishment of the Victoria Institute was to examine the questions as to which there was a *prima facie* appearance of conflict between the conclusions of science and the teachings of revelation. In order that such examination may be usefully carried out, it must be undertaken in a thoroughly impartial spirit, with a readiness honestly to follow truth wherever it may lead. It will not do to assume that the immunity from error which belongs to the divine belongs also to our apprehension of what constitutes the divine, and that therefore, if a conflict there be, the error must be on the side of science. It is true that many statements, which are really little more than scientific conjectures, are represented, at least by those who take their science at second or third hand, as if they were the well-established conclusions of science. But it is true also that the progress of science has corrected the assertions of a crude theology. We are disposed nowadays to smile at the idea of any opposition between the Copernican system and the teaching of revelation; but we need not go back to the days of the persecution of Galileo to find an example of a well-supported scientific conclusion having met with a similar opposition, issuing in a similar result.

To gauge thoroughly the amount of evidence on which an asserted scientific conclusion rests, one ought to be well acquainted with the branch of science to which it relates. Still, one can get a fair general notion of the evidence by an amount of reading which is by no means prohibitive, or by conversing with those who have made that branch a special study. It may be that the impression thus left on the mind will be that the votaries of science, carried away by an excess of zeal in the attempt to discover the causes of natural phenomena, have really, though honestly, overestimated the evidence. It may be, on the other hand, that the inquirer will perceive the evidence to be weighty and substantial, in which case it behooves him to reconsider the supposition with which he started, that the conclusion was opposed to the teaching of revelation.

One should always bear in mind the great responsibility one incurs, and the mischief one may do, by representing as bound up with revelation that which really forms no part of it. Being by hypothesis no part of it, but only erroneously tacked on to it, it may be false, and, being false, it may be in opposition to a conclusion supported by the weightiest evidence, it matters not of what kind, but say scientific. What, then, will be the effect of the error committed by the upholder of revelation? The educated man of science may see through the fallacy; but will it not put a weapon into the hands of the infidel lecturer wherewith to attack revealed religion?

But whether we can agree or can not agree with the conclusions at which the scientific investigator may have arrived, let us, above all things, beware of imputing evil motives to him; of charging him with adopting his conclusions for the purpose of opposing what is revealed. Scientific investigation is eminently truthful. The investigator may be wrong, but it does not follow that he is other than truth-loving. If on some subjects which we deem of the highest importance he does not agree with us—and yet it may be he agrees with us more than we suppose—let us, remembering our own imperfections, both of understanding and of practice, bear in mind that caution of the Apostle: "Who art thou that judgest another man's servant? To his own master he standeth or falleth."—*Nature*.

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF AUTUMN.

By GARRETT P. SERVISS.

IN the "Fifth Evening" of that delightful, old, out-of-date book of Fontenelle's, on the "Plurality of Worlds," the Astronomer and the Marchioness, who have been making a wonderful pilgrimage through the heavens during their evening strolls in the park, come at last to the starry systems beyond the "solar vortex," and the Marchioness experiences a lively impatience to know what the fixed stars shall turn out to be, for the Astronomer has sharpened her appetite for marvels.

"Tell me," says she, eagerly, "are they, too, inhabited like the planets, or are they not peopled? In short, what can we make of them?"

The Astronomer answers his charming questioner, as we should do to-day, that the fixed stars are so many suns. And he adds to this information a great deal of entertaining talk about the planets that may be supposed to circle around these distant suns, interspersing his conversation with explanations of "vortexes," and many quaint conceits, in which he is helped out by the ready wit of the Marchioness.

Finally, the impressionable mind of the Marchioness is overwhelmed by the grandeur of the scenes that the Astronomer opens to her view, her head swims, infinity oppresses her, and she cries for mercy.

"You show me," she exclaims, "a perspective so interminably long that the eye can not see the end of it. I see plainly the inhabitants of the earth; then you cause me to perceive those of the moon and of the other planets belonging to our vortex (system), quite clearly, yet not so distinct as those of the earth. After them come the inhabitants of planets in the other vortexes. I confess, they seem to me hidden deep in the background, and, however hard I try, I can barely glimpse them at all. In truth, are they not almost annihilated by the very expression which you are obliged to use in speaking of them? You have to call them inhabitants of one of the planets contained in one out of the infinity of vortexes. Surely we ourselves, to whom the same expression applies, are almost lost among so many millions of worlds. For my part, the earth begins to appear so frightfully little to me that henceforth I shall hardly consider any object worthy of eager pursuit. Assuredly, people who seek so earnestly their own aggrandizement, who lay schemes upon schemes, and give themselves so much trouble, know nothing of the vortexes! I am sure my increase of knowledge will redound to the credit of my idleness, and when people reproach me with indolence I shall reply: 'Ah! if you but knew the history of the fixed stars!'"

It is certainly true that a contemplation of the unthinkable vastness of the universe, in the midst of which we dwell upon a speck illuminated by a spark, is calculated to make all terrestrial affairs appear contemptibly insignificant. We can not wonder that men for ages regarded the earth as the center, and the heavens with their lights as tributary to it, for to have thought otherwise, in those times, would have been to see things from the point of view of a superior intelligence. It has taken a vast amount of experience and knowledge to

Map I.

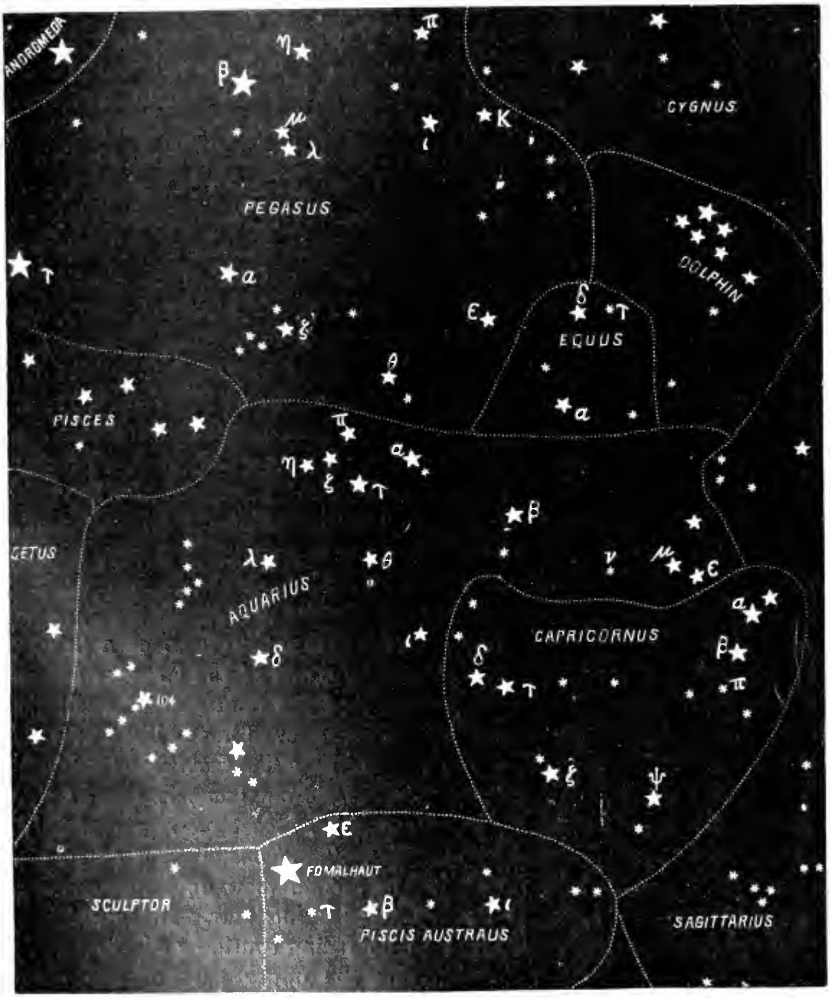
convince men of the parvitude of themselves and their belongings. So, in all ages they have applied a terrestrial measure to the universe, and imagined they could behold human affairs reflected in the heavens and human interests setting the gods together by the ears.

This is clearly shown in the story of the constellations. The tremendous truth that on a starry night we look, in every direction, into an almost endless vista of suns beyond suns and systems upon systems, was too overwhelming for comprehension by the inventors of the constellations. So they amused themselves, like imaginative children, as they were, by tracing the outlines of men and beasts formed by those pretty lights, the stars. They turned the starry heavens into a scroll filled with pictured stories of mythology. Four of the constellations with which we are going to deal in this article are particularly interesting on this account. They preserve in the stars, more lasting than parchment or stone, one of the oldest and most pleasing of all the romantic stories that have amused and inspired the minds of men —the story of Perseus and Andromeda—a better story than any that modern novelists have invented. The four constellations to which I have referred bear the names of Andromeda, Perseus, Cassiopeia, and Cepheus, and are sometimes called, collectively, the Royal Family. In the autumn they occupy a conspicuous position in the sky, forming a group that remains unrivaled until the rising of Orion with his imperial *cortège*. The reader will find them in our circular map, occupying the northeastern quarter of the heavens.

This map represents the visible heavens at about midnight on September 1st, ten o'clock P. M. on October 1st, and eight o'clock P. M. on November 1st. At this time the constellations that were near the meridian in summer will be found sinking in the west, Hercules being low in the northwest, with the brilliant Lyra and the head of Draco suspended above it; Aquila, "the eagle of the winds," soars high in the southwest; while the Cross of Cygnus is just west of the zenith; and Sagittarius, with its wealth of star-dust, is disappearing under the horizon in the southwest.

Far down in the south the observer catches the gleam of a bright lone star of the first magnitude, though not one of the largest of that class. It is Fomalhaut, in the mouth of the Southern Fish, Piscis Australis. A slight reddish tint will be perceived in the light of this beautiful star whose brilliancy is enhanced by the fact that it shines without a rival in that region of the sky. Fomalhaut is one of the important "nautical stars," and its position was long ago carefully computed for the benefit of mariners. The constellation of Piscis Australis, which will be found in our second map, does not possess much to interest us except its brilliant leading star. In consulting Map 2, the observer is supposed to be facing south, or slightly west of south, and he must remember that the upper part of the map reaches nearly to the zenith, while at the bottom it extends down to the horizon.

To the right, or west, of Fomalhaut, and higher up, is the constellation of Capricornus, very interesting on many accounts, though by no means a striking constellation to the unassisted eye. The stars Alpha (α), called Giedi, and Beta (β), called Dabih, will be readily recognized, and a keen eye will perceive that Alpha really consists of two stars. They are about six minutes of arc apart, and are of the third and the fourth magnitude respectively. These stars, which to the naked eye appear almost blended into one, really have no physical connection with each other, and are slowly drifting apart. The ancient astronomers make no mention of Giedi being composed of two stars, and the reason is plain, when it is known that in the time of Hippar-



Map 2.

chus, as Flammarion has pointed out, their distance apart was not more than two thirds as great as it is at present, so that the naked eye would not have detected the fact that there were two of them: and it was not until the seventeenth century that they got far enough asunder to begin to be separated by eyes of unusual power. With an ordinary opera-glass they are thrown well apart, and present a very pretty sight. The star Beta, or Dabih, is also a double star with a glass magnifying five or six times, the smaller star being of the seventh magnitude and sky-blue in color.

The star Rho (ρ) is a double that will severely test your glass, and it is useless to undertake to see the companion unless your magnifying power is as much as six times, and the glass of excellent quality.

With the most powerful glass at your disposal, sweep from the star Zeta (ζ) eastward a distance somewhat greater than that separating Alpha and Beta, and you will find a fifth-magnitude star beside a little nebulous spot. This is the cluster known as M 30, one of those sun-swarms that overwhelm the mind of the contemplative observer with astonishment, and especially remarkable in this case for the apparent vacancy of the heavens immediately surrounding the cluster, as if all the stars in that neighborhood had been drawn into the great assemblage, leaving a void around it. Of course, with the instrument that our observer is supposed to be using, merely the *existence* of this solar throng can be detected; but, if he sees that it is there, he may be led to provide himself with a telescope capable of revealing its glories.

Admiral Smyth remarks that "although Capricorn is not a striking object, it has been the very pet of all constellations with astrologers," and he quotes from an old almanac of the year 1386 that "whoso is borne in Capcorn schal be ryche and wel lufyd." The mythological account of the constellation is that it represents the goat into which Pan was turned in order to escape from the giant Typhon, who once on a time scared all the gods out of their wits, and caused them to change themselves into animals, even Jupiter assuming the form of a ram. According to some authorities, Piscis Australis represents the fish into which Venus changed herself on that interesting occasion.

Directly above Piscis Australis, and to the east or left of Capricorn, the map shows the constellation of Aquarius, or the Water-Bearer. Some say this represents Ganymede, the cup-bearer of the gods. It is represented in old star-maps by the figure of a young man pouring water from an urn. The star Alpha (α) marks his right shoulder, and Beta (β) his left, and Gamma (γ), Zeta (ζ), Eta (η), and Pi (π) indicate his right hand and the urn. From this group a current of small stars will be recognized, sweeping downward with a curve toward the east, and ending at Fomalhaut; this represents the water poured from the urn, which the Southern Fish appears to be drinking. It is worthy of remark, that in Greek, Latin, and Arabic this constellation bears names all of which signify "a man pouring water." The ancient Egyptians imagined that the setting of Aquarius caused the rising of the Nile, as he sank his huge urn in the water to fill it. Alpha Aquarii was called by the Arabs Sadalmelik, which is interpreted to mean the "king's lucky star," but whether it proved itself a lucky star in war or in love, and what particular king enjoyed its benign influence and recorded his gratitude in its name, we are not informed. Thus, at every step, we find how shreds of history and bits of superstition are entangled among the stars. Surely, humanity has reflected itself in the heavens, at least as lastingly as it has impressed itself upon the earth.

Starting from the group of stars just described as making the Water-Bearer's urn, follow with a glass the winding stream of small stars that represents the water. Several very pretty and striking assemblages of stars will be encountered in its course. The star Tau (τ) is double and presents a beautiful contrast of color, one star being white and the other reddish-orange—two solar systems, it may be, apparently neighbors as seen from the earth, though really enormously far apart, in one of which daylight is white and in the other red!

Point a good glass upon the star marked Nu (ν), and you will see, somewhat less than a degree and a half to the west of it, what appears to be a faint star of between the seventh and eighth magnitudes. You will have to look sharp to see it. It is with your mind's eye that you must gaze, in order to perceive the wonder here hidden in the depths of space. That faint speck is a nebula, unrivaled for interest by many of the larger and more conspicuous objects of that kind. Lord Rosse's great telescope has shown that in form it resembles the planet Saturn; in other words, that it consists apparently of a ball surrounded by a ring. But the spectroscope proves that it is a gaseous mass, and the micrometer—supposing its distance to be equal to that of the stars, and we have no reason to think it less—that it must be large enough to fill the whole space included within the orbit of Neptune! Here, then, as has been said, we seem to behold a genesis in the heavens. If Laplace's nebular hypothesis, or any of the modifications of that hypothesis, represents the process of formation of a solar system, then we may fairly conclude that such a process is now actually in operation in this nebula in Aquarius, where a vast ring of nebulous matter appears to have separated off from the spherical mass within it. This may not be the true explanation of what we see there, but, whatever the explanation may be, there can be no question of the high significance of this nebula, whose form proclaims unmistakably the operation of great metamorphic forces there. Of course, with his insignificant optical means, our observer can see nothing of the strange form of this object, the detection of which requires the aid of the most powerful telescopes, but it is much to know where this unfinished creation lies, and to see it, even though diminished by distance to a mere speck of light.

Turn your glass upon the star shown in the map just above Mu (μ) and Epsilon (ϵ). You will find an attractive arrangement of small stars in its neighborhood. The star marked 104 is double to the naked eye, and the row of stars below it is well worth looking at. The star Delta (δ) is interesting, because, in 1756, Tobias Mayer narrowly escaped making a discovery there that would have anticipated that which a quarter of a century later made the name of Sir William Herschel world-renowned. The planet Uranus passed near Delta in 1756, and Tobias Mayer saw it, but it moved so slowly that he took it for a fixed star, never suspecting that his eyes had rested upon a member of the solar system whose existence was, up to that time, unknown to the inhabitants of Adam's planet.

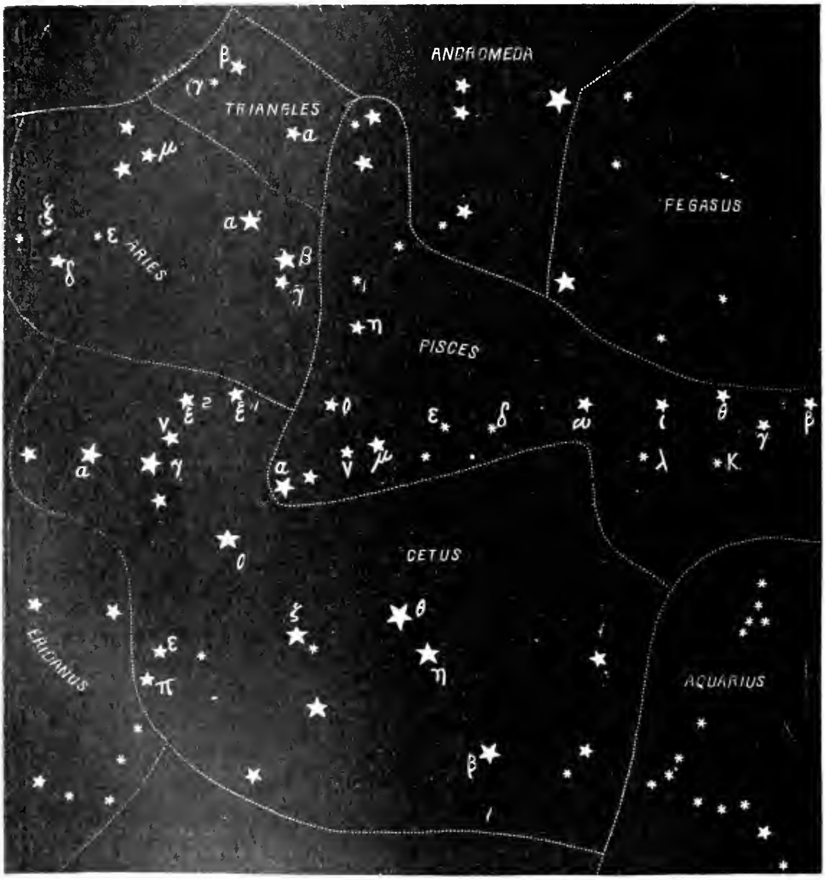
Above Aquarius you will find the constellation Pegasus. It is conspicuously marked by four stars of about the second magnitude, which shine at the corners of a large square, called the Great Square of Pegasus. This figure is some fifteen degrees square, and at once attracts the eye, there being few stars visible within the quadrilateral, and no large ones in the immediate neighborhood to distract attention from it. One of the four stars, however, as will be seen by consulting Map 2, does not belong to Pegasus, but to the constellation Andromeda. Mythologically, this constellation represents the celebrated winged horse of antiquity :

> "Now heaven his further wandering flight confines,
> Where, splendid with his numerous stars, he shines."

The star Alpha (α) is called Markab ; Beta (β) is Scheat, and Gamma (γ) is Algenib ; the fourth star in the square, belonging to Andromeda, is called Alpheratz. Although Pegasus presents a striking appearance to the unassisted eye, on account of its great square, it contains little to attract the observer with an opera-glass. It will prove interesting, however, to sweep with the glass carefully over the space within the square, which is comparatively barren to the naked eye, but in which many small stars will be revealed, of whose existence the naked-eye observer would be unaware. The star marked Pi (π) is an interesting double, which can be separated by a good eye without artificial aid, and which, with an opera-glass, presents a fine appearance.

And now we come to our third little map, representing the constellations Cetus, Pisces, Aries, and the Triangles. In consulting it the observer is supposed to face the southeast. Cetus is a very large constellation, and from the peculiar conformation of its principal stars it can be readily recognized. The head is to the east, the star Alpha (α), called Menkar, being in the nose of this imaginary monster of the sky-depths. This constellation is supposed to represent the monster that was sent, according to the fable, by Neptune to devour the fair Andromeda, but whose bloodthirsty design was happily and gallantly frustrated by Perseus, as we shall learn from starry mythology farther on.

By far the most interesting object in Cetus is the star Mira, marked Omicron (o) in the map. This is a famous variable star—a sun that sometimes shines a thousand times more brilliantly than at others ! It changes from the second magnitude to the ninth or tenth, its period from maximum to maximum being about eleven months. During about five months of that time it is completely invisible to the naked eye; then it begins to appear again, slowly increasing in brightness for some three months, until it shines as a star of the second magnitude, being then as bright as if not brighter than the most brilliant stars in the constellation. It retains this brilliancy for about two weeks, and



Map 3.

then begins to fade again, and, in about three months, once more disappears. There are various irregularities in its changes, which render its exact period somewhat uncertain, and it does not always attain the same degree of brightness at its maximum. For instance, in 1779, Mira was almost equal in brilliancy to a first-magnitude star, but frequently at its greatest brightness it is hardly equal to an ordinary star of the second magnitude. Mira will attain its greatest brilliancy about the 2d of November, this year. By the aid of our little map you will readily be able to find it. You will perceive that it has a slightly reddish tint. Watch it during the coming winter, and you will see it gradually fade from sight until, at last, only the blackness of the empty sky appears where, a few months before, a conspicuous and brilliant star was seen. Keep watch of that spot next summer, and in July you will perceive Mira shining there again—a mere speck, but slowly brightening—and next fall the wonderful star will blaze out again with renewed splendor.

Knowing that our own sun is a variable star—though variable only to a slight degree, its variability being due to the spots that appear upon its surface in a period of about eleven years—we possess some light that may be cast upon the mystery of Mira's variations. It seems not improbable that, in the case of Mira, the surface of the star at the maximum of spottedness is covered to an enormously greater extent than occurs during our own sun-spot maxima, so that the light of the star, instead of being merely dimmed to an almost imperceptible extent, as with our sun, is almost blotted out. When the star blazes with unwonted splendor, as in 1779, we may fairly assume that the pent-up forces of this perishing sun have burst forth, as in a desperate struggle against extinction. But nothing can prevail against the slow, remorseless, resistless progress of that obscuration, which comes from the leaking away of the solar heat, and which constitutes what we may call the death of a sun. And that word seems peculiarly appropriate to describe the end of a body which, during its period of visible existence, not only presents the highest type of physical activity, but is the parent and supporter of all forms of life upon the planets that surround it.

We might even go so far as to say that possibly Mira presents to us an example of what our sun will be in the course of time, as the dead and barren moon shows us, as in a magician's glass, the approaching fate of the earth. Fortunately, human life is a mere span in comparison with the æons of cosmic existence, and so we need have no fear that either we or our descendants for thousands of generations shall have to play the tragic *rôle* of Campbell's "Last Man," or be induced to keep up a stout heart amid the crash of time by ungenerously boasting to the perishing sun, whose rays had nurtured us, that, though his proud race is ended, we have confident anticipations of immortality. I trust that, when man makes his exit from this terrestrial stage, it will not be in the contemptible act of thus kicking a fallen benefactor.

There are several other variable stars in Cetus, but none possessing much interest for us. The observer should look at the group of stars in the head, where he will find some interesting combinations, and also at the star Chi, which is the little star shown in the map near Zeta (ζ). This is a double that will serve as a very good test of eye and instrument, the smaller companion-star being of only seven and a half magnitude.

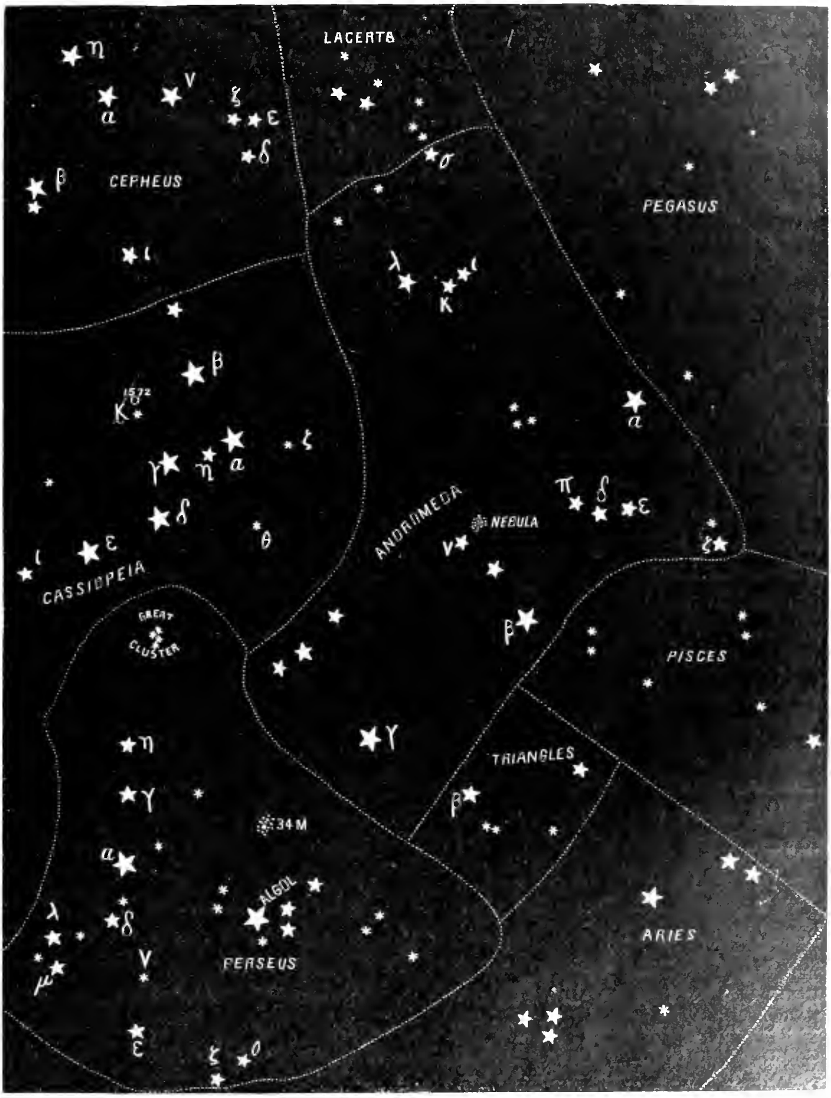
Directly above Cetus is the long, straggling constellation of Pisces, the Fishes. The Northern Fish is represented by the group of stars near Andromeda and the Triangles. A long band or ribbon, supposed to bind the fish together, trends thence first southeast and then west until its joins a group of stars under Pegasus, which represents the Western Fish, not to be confounded with the Southern Fish described near the beginning of this article, which is a separate constellation. Fable has, however, somewhat confounded these fishes; for while, as I have remarked above, the Southern Fish is said to represent Venus after she had turned herself into a fish to escape from the giant Typhon, the two fishes of the constellation we are now dealing with are also fabled to represent Venus and her interesting son Cupid under the same disguise assumed on the same occasion. If Typhon, however, was so great a brute that even Cupid's arrows were of no avail against him, we should, perhaps, excuse mythology for duplicating the record of so wondrous an event.

You will find it very interesting to take your glass and, beginning with the attractive little group in the Northern Fish, follow the windings of the ribbon, with its wealth of little stars, to the Western Fish. When you have arrived at that point, sweep well over the sky in that neighborhood, and particularly around and under the stars Iota (ι), Theta (θ), Lambda (λ) and Kappa (κ). If you are using a powerful glass, you will be surprised and delighted by what you see. Below the star Omega (ω), and to the left of Lambda, is the place which the sun occupies at the time of the spring equinox—in other words, one of the two crossing-places of the equinoctial or the equator of the heavens, and the ecliptic, or the sun's path. The prime meridian of the heavens passes through this point.

To the left of Pisces, and above the head of Cetus, is the constellation Aries, or the Ram. Two pretty bright stars, four degrees apart, one of which has a fainter star near it, mark it out plainly to the eye. These stars are in the head of the Ram. The brightest one, Alpha (α) is called Arietis; Beta (β) is named Sheratan; and its fainter neighbor is Mesarthim. According to fable, this constellation represents the ram that wore the golden fleece, which was the object of the celebrated expedition of the Argonauts. There is not much in the constellation to interest us, except its historical importance, as it was more than two thousand years ago the leading constellation of the zodiac, and still stands first in the list of the zodiacal signs. Owing to the precession of the equinoxes, however, the vernal equinoctial point, which was formerly in this constellation, has now advanced into the constellation Pisces, as we saw above.

The little constellation of the Triangles, just above Aries, is worth only a passing notice. Insignificant as it appears, this little group is a very ancient constellation.

And now we come to the so-called "Royal Family." Although the story of Perseus and Andromeda is, of course, well known to nearly all readers, yet, on account of the great beauty and brilliancy of the group of constellations that perpetuate the memory of it among the stars, it is worth recalling here. It will be remembered that, as



MAP 4.

Perseus was returning through the air from his conquest of
gon Medusa, he saw the beautiful Andromeda chained to
the sea-coast, waiting to be devoured by a sea-monster
girl's only offense was that her mother, Cassiopeia, had

her that she was fairer than the sea-beauty, Atergatis, and for this Neptune had decreed that all the land of the Ethiopians should be drowned and destroyed unless Andromeda was delivered up as a sacrifice to the dreadful sea-monster. When Perseus, dropping down to learn why this maiden was chained to the rocks, heard from Andromeda's lips the story of her woes, he laughed with joy. Here was an adventure just to his liking, and besides, unlike his previous adventures, it involved the fate of a beautiful woman with whom he was already in love. Could he save her? Well, wouldn't he! The sea-monster might frighten a kingdom full of Ethiops, but it could not shake the nerves of a hero from Greece. He whispered words of encouragement to Andromeda, who could scarce believe the good news that a champion had come to defend her after all her friends and royal relations had deserted her. Neither could she feel much confidence in her young champion's powers when suddenly her horrified gaze met the awful monster of the deep advancing to his feast! But Perseus, with a warning to Andromeda not to look at what he was about to do, sprang with his winged sandals up into the air. And then, as Charles Kingsley has so beautifully told the story—

"On came the great sea-monster, coasting along like a huge black galley, lazily breasting the ripple, and stopping at times by creek or headland to watch for the laughter of girls at their bleaching, or cattle pawing on the sand-hills, or boys bathing on the beach. His great sides were fringed with clustering shells and sea-weeds, and the water gurgled in and out of his wide jaws as he rolled along, dripping and glistening in the beams of the morning sun. At last he saw Andromeda, and shot forward to take his prey, while the waves foamed white behind him, and before him the fish fled leaping.

"Then down from the height of the air fell Perseus like a shooting-star—down to the crest of the waves, while Andromeda hid her face as he shouted. And then there was silence for a while.

"At last she looked up trembling, and saw Perseus springing toward her: and instead of the monster, a long, black rock, with the sea rippling quietly round it."

Perseus had turned the monster into stone by holding the awful head of Medusa before his eyes; and it was fear lest Andromeda herself might see the Gorgon's head, and suffer the fate of all who looked upon it, that had led him to forbid her watching him when he attacked her enemy. Of course he married her, and of course Cassiopeia, Andromeda's mother, and Cepheus, her father, gave their daughter's rescuer a royal welcome, and all the Ethiops rose up and blessed him for ridding the land of the monster. And now, if we choose, we can, any fair night, see the principal characters of this old romance shining in starry garb in the sky. Aratus saw them there in his day, more than two hundred years before Christ, and has left this description in his "Skies," as translated by Poste:

"Nor shall blank silence whelm the harassed house
Of Cepheus; the high heavens know their name,
For Zeus is in their line at few removes.
Cepheus himself by She-bear Cynosure,
Iasid king stands with uplifted arms.
From his belt thou castest not a glance
To see the first spire of the mighty Dragon.

"Eastward from him, heaven-troubled queen, with scanty stars
But lustrous in the full-mooned night, sits Cassiopeia.
Not numerous nor double-rowed
The gems that deck her form,
But like a key which through an inward-fastened
Folding-door men thrust to knock aside the bolts,
They shine in single, zigzag row.
She, too, o'er narrow shoulders stretching
Uplifted hands, seems wailing for her child.

"For there, a woful statue form, is seen
Andromeda, parted from her mother's side. Long I trow
Thou wilt not seek her in the nightly sky,
So bright her head, so bright
Her shoulders, feet, and girdle.
Yet even there she has her arms extended,
And shackled even in heaven; uplifted,
Outspread eternally are those fair hands.

"Her feet point to her bridegroom
Perseus, on whose shoulder they rest.
He in the north-wind stands gigantic,
His right hand stretched toward the throne
Where sits the mother of his bride. As one bent on some high deed,
Dust-stained he strides over the floor of heaven."

The makers of old star-maps seem to have vied in the effort to represent with effect the figures of Andromeda, Perseus, and Cassiopeia among the stars, and it must be admitted that some of them succeeded in giving no small degree of life and spirit to their sketches.

The starry riches of these constellations are well matched with their high mythological repute. Lying in and near the Milky-Way, they are particularly interesting to the observer with an opera-glass. Besides, they include several of the most celebrated wonders of the firmament.

In consulting our fourth map, the observer is supposed to face the east and northeast. We will begin our survey with Andromeda. The three chief stars of this constellation are of the second magnitude, and lie in a long, bending row, beginning with Alpha (α), or Alpheratz, in the head, which, as we have seen, marks one corner of the great Square of Pegasus. Beta (β), or Mirach, with the smaller stars Mu (μ) and Nu (ν), form the girdle. The third of the chief stars is Gamma (γ), or Almaach, situated in the left foot. The little group of stars designated Lambda (λ), Kappa (κ), and Iota (ι), mark the extended right hand chained to the rock, and Zeta (ζ) and some smaller stars southwest of it show the left arm and hand, also stretched forth and shackled.

In searching for picturesque objects in Andromeda, begin with Alpheratz and the groups forming the hands. Below the girdle will be seen a rather remarkable arrangement of small stars in the mouth of the Northern Fish. Now follow up the line of the girdle to the star Nu (ν). If your glass has a pretty wide field, your eye will immediately catch the glimmer of the Great Nebula of Andromeda in the same field with the star. This is the oldest or earliest discovered of the nebulæ, and, with the exception of that in Orion, is the grandest visible in this hemisphere. Of course, not much can be expected of an opera-glass in viewing such an object; and yet a good glass, in clear weather and the absence of the moon, makes a very attractive spectacle of it.

By turning the eyes aside, the nebula can be seen, extended as a faint, wispy light, much elongated on either side of the brighter nucleus. The cut here given shows, approximately, the appearance of the nebula, together with some of the small stars in its neighborhood, as seen with a field-glass. With large telescopes it appears both larger and broader, expanding to a truly enormous extent, and in Bond's celebrated picture of it we behold gigantic rifts running through it, while the whole field of sky in which it is contained appears sprinkled over with minute stars apparently between us and the nebula. It was in, or probably more properly speaking, in line with, this nebula that a new star suddenly shone out in 1885, and, after flickering and fading for a few months, disappeared. That the outburst of light in this star had any real connection with the nebula is exceedingly improbable. Although it appeared to be close beside the bright nucleus of the nebula, it is likely that it was really hundreds or thousands of millions of miles either this side or the other side of it. Why it should suddenly have blazed into visibility, and then in so short a time have disappeared, is a question as difficult as it is interesting. The easiest way to account for it, if not the most satisfactory,

MAP 5.—THE GREAT ANDROMEDA NEBULA.

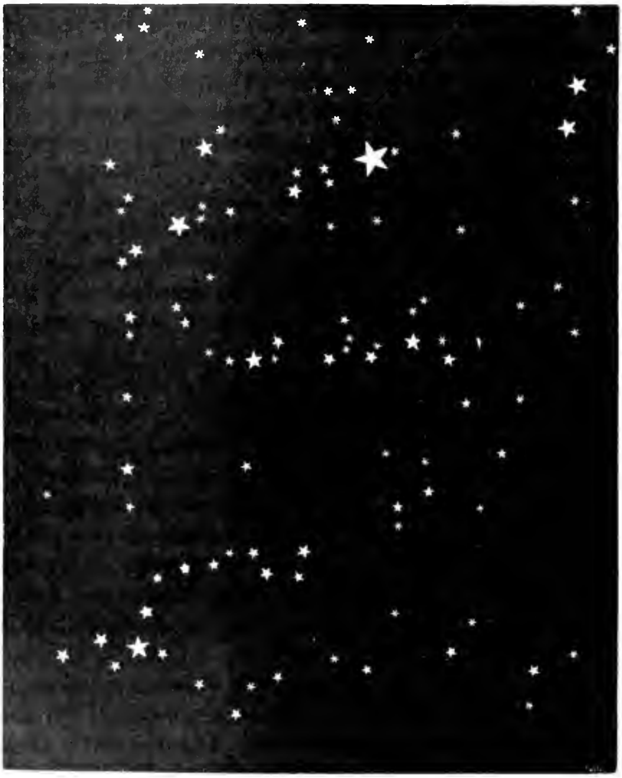
is to assume that it is a variable star of long period, and possessing a very wide range of variability. One significant fact that would seem to point to some connection between star and the nebula, after all, is that a similar occurrence was noticed in the constellation Scorpio in 1860, and to which I have previously referred (see "Popular Science Monthly" for June, 1887). In that case a faint star projected against the background of a nebula, suddenly flamed into comparatively great brilliancy, and then faded again. The chances against the accidental superposition of a variable star of such extreme variability upon a known nebula occurring twice are so great that for that reason alone we might be justified in thinking some mysterious causal relation must in each case exist between the nebula and the star. The temptation to indulge in speculation is very great here, but it is better to wait for more light, and confess that for the present these things are inexplicable.

It will be found very interesting to sweep with the glass slowly from side to side over Andromeda, gradually approaching toward Cassiopeia or Perseus. The increase in the richness of the stratum of faint stars that apparently forms the background of the sky will be clearly discernible as you approach the Milky-Way, which passes directly through Cassiopeia and Perseus. It may be remarked that the Milky-Way itself, in that splendidly rich region about Sagittarius (described in the "Stars of Summer"), is not nearly so effective an object with an opera-glass as it is above Cygnus and in the region with which we are now dealing. This seems to be owing to the smaller magnitude of its component stars in the southern part of the stream. There the background appears more truly "milky," while in the northern region the little stars appear distinct, like diamond-specks on a black background.

The star Nu, which serves as a pointer to the Great Nebula, is itself worth some attention with a pretty strong glass on account of a pair of small stars near it.

Next let us turn to Perseus. The bending row of stars marking the center of this constellation is very striking and brilliant. The brightest star in the constellation is Alpha, or Algenib, in the center of the row. The head of Perseus is toward Cassiopeia, and in his left hand he grasps the head of Medusa, which hangs down in such a way that its principal star Beta, or Algol, forms a right angle with Algenib and Almaach in Andromeda. This star Algol, or the Demon, as the Arabs call it, is in some respects the most wonderful and interesting in all the heavens. It is as famous for the variability of its light as Mira, but it differs widely from that star both in its period, which is very short, and in the extent of the changes it undergoes. During about two days and a half, Algol is equal in brilliancy to Algenib, which is a second-magnitude star; then it begins to fade, and in the course of about four and a half hours it sinks to the fourth magnitude.

being then about equal to the faint stars near it. It remains thus obscured for only a few minutes, and then begins to brighten again, and in about four and a half hours more resumes its former brilliancy. This phenomenon is very easily observed, for, as will be seen by consulting our little map, Algol can be readily found, and its changes are



MAP 6.—THE ATTENDANTS OF ALPHA PERSEI.

so rapid that under favorable circumstances it can be seen in the course of a single night to run through the whole gamut. Of course, no optical instrument whatever is needed to enable one to see these changes of Algol for it is plainly visible to the naked eye throughout, but it will be found interesting to watch the star with an opera-glass. Its periodic time from minimum to minimum is two days, twenty hours, and forty-nine minutes, lacking a few seconds. Any one can calculate future minima for himself by adding the periodic time above given to the time of any observed minimum. For instance, there will be a minimum on November 12th at about 11.15 P. M., then the next minimum will occur two days, twenty hours and forty-nine minutes later, or at 8.04 P. M., on November 15th.

While spots upon its surface may be the cause of the variations in the light of Mira, it is believed that the more rapid changes of Algol may be due to another cause; namely, the existence of a huge, dark body revolving swiftly around it at close quarters in an orbit whose plane is directed edgewise toward the earth, so that at regular intervals this dark body causes a partial eclipse of Algol. Notwithstanding the attacks that have been made upon this theory, it seems to hold its ground, and it will probably continue to find favor as a working hypothesis until some fresh light is cast upon the problem. It hardly needs to be said that the dark body in question, if it exists, must be of enormous size, bearing no such insignificant proportion to the size of Algol as the earth does to the sun, but being rather the rival in bulk of its shining brother—a blind companion, an extinguished sun.

There was certainly great fitness in the selection of the little group of stars of which this mysterious Algol forms the most conspicuous member, to represent the awful head of the Gorgon carried by the victorious Perseus for the confusion of his enemies. In a darker age than ours the winking of this demon star must have seemed a prodigy of sinister import.

Turn now to the bright star Algenib, or Alpha Persei. You will find with the glass an exceedingly attractive spectacle there. In my note-book I find this entry, made while sweeping over Perseus for materials for this article: "The field about Alpha is one of the finest in the sky for an opera-glass. Stars conspicuously ranged in curving lines and streams. A host follows Alpha from the east and south." The picture above will give the reader some notion of the exceeding beauty of this field of stars, and of the singular manner in which they are grouped, as it were, behind their leader. A field-glass increases the beauty of the scene.

The reader will find a starry cluster marked on Map 4 as the "Great Cluster." This object can be easily detected by the naked eye, resembling a wisp of luminous cloud. It marks the hand in which Perseus clasps his diamond sword, and, with a telescope of medium power, it is one of the most marvelously beautiful objects in the sky —a double swarm of stars, bright enough to be clearly distinguished from one another, and yet so numerous as to dazzle the eye with their lively beams. An opera-glass does not possess sufficient power to "resolve" this cluster, but it gives a startling suggestion of its half-hidden magnificence, and the observer will be likely to turn to it again and again with increasing admiration. Sweep from this to Alpha Persei and beyond to get an idea of the procession of suns in the Milky-Way. The nebulous-looking cluster marked 34 M appears with an opera-glass like a faint comet.

Next look at Cassiopeia, which is distinctly marked out by the zigzag row of stars so well described by Aratus. Here the Milky-Way is so rich that the observer hardly needs any guidance; he is sure to stumble upon interesting sights for himself. The five brightest stars are generally represented as indicating the outlines of the chair or throne in which the queen sits, the star Zeta (ζ) being in her head. Look at Zeta with a good field-glass, and you will see a singular and brilliant array of stars near it in a broken half-circle, which may suggest the notion of a crown. Near the little star Kappa (κ) in the map will be seen a small circle and the figures 1572. This shows the spot where the famous temporary star, which has of late been frequently referred to as the "Star of Bethlehem," appeared. It was seen in 1572, and carefully observed by the famous astronomer Tycho Brahe. It seems to have suddenly burst forth with a brilliancy that outshone every other star in the heavens, not excepting Sirius itself. But its supremacy was short-lived. In a few months it had sunk to the second magnitude. It continued to grow fainter, exhibiting some remarkable changes of color in the mean time, and in less than a year and a half it had disappeared. It has never been seen since. But in 1264, and again in 945, a star is said to have suddenly blazed out near that point in the heavens. There is no certainty about these earlier apparitions, but, assuming that they are not apocryphal, they might possibly indicate that the star seen by Tycho was a periodical one, its period considerably exceeding three hundred years. Carrying this supposed period back, it was found that an apparition of this star might have occurred about the time of the birth of Christ. It did not require a very prolific imagination to suggest its identity with the so-called star of the Magi, and hence the legend of the Star of Bethlehem and its impending reappearance of which we have heard so much of late. It will be observed, from the dates given above, that, even supposing them to be correct, no definite period is indicated for the reappearances of the star. In one case the interval is three hundred and eight years, and in the other three hundred and nineteen years. In short, there are too many suppositions and assumptions involved to allow of any credence being given to the theory of the periodicity of Tycho's wonderful star. At the same time, nobody can say it is impossible that the star should appear again, and so it may be interesting for the reader to know where to look for it.

Many of the most beautiful sights of this splendid constellation are beyond the reach of an opera-glass, and reserved for the grander powers of the telescope.

We will pause but a minute with Cepheus, for the old king's constellation is comparatively dim in the heavens, as his part in the dramatic story of Andromeda was contemptible, and he seems to have got among the stars only by virtue of his relationship to more interesting persons. He does possess one gem of singular beauty—the star Mu, which may be found about half-way from Alpha to the group of stars in the king's head, named Zeta (ζ), Epsilon (ϵ), and Delta (δ), and a little southwest of a line joining them. It is the so-called "Garnet Star," thus named by William Herschel, who advises the observer, in order to appreciate its color, to glance from it to Alpha Cephei, which is a white star. Mu is variable, changing from the fourth to the sixth magnitude in a long period of five or six years. Its color is changeable, like its light. Sometimes it is of a deep garnet hue, and at other times it is orange-colored. Upon the whole, it appears of a deeper red than any other star visible to the naked eye.

If you have a good field-glass, try its powers upon the star Delta (δ) Cephei. This is a double star, the components being about forty-one seconds of arc apart, the larger of four and one half magnitude, and the smaller of the seventh magnitude. The latter is of a beautiful blue color, while the larger star is yellow or orange. With a good eye, a steady hand, and a clear glass, magnifying not less than six diameters, you can separate them, and catch the contrasted tints of their light. Besides being a double star, Delta is variable.

ABOUT THE WEDDING-RING.

By D. R. McANALLY.

OF all the ornaments with which vanity, superstition, and affection have decorated the human form, few have more curious bits of history than the finger-ring. From the earliest times the ring has been a favorite ornament, and the reasons for this general preference shown for it over other articles of jewelry are numerous and cogent. Ornaments whose place is on some portion of the apparel, or in the hair, must be laid aside with the clothing or head-dress; are thus easily lost and often not at once missed. Pins, brooches, buckles, clasps, buttons, all sooner or later become defective in some part, and are liable to escape from an owner unconscious of the defect in the mechanism. The links of a necklace in time become worn, and the article is taken off to be mended; the spring or other fastening of a bracelet is easily broken, and the bracelet vanishes. With regard to ornaments fastened to parts of the savage body, mutilation is necessary, the ear must be bored, the nose be pierced, the cheeks or lips be slit, and, even after these surgical operations are completed, the articles used for adornment are generally inconvenient, and sometimes, by their weight or construction, are extremely painful.

In striking contrast with decorations worn on the clothing, in the hair, round the neck and arms, or pendent from the ears, lips, and nose, is the finger-ring, the model of convenience. It is seldom lost, for it need not be taken off; requires no preparatory mutilation of the body, is not painful, is always in view, a perpetual reminder, either of the giver, or of the purpose for which it is worn.

The popularity of the ring must, therefore, be in large measure due to its convenience, and that this good quality was early learned may be inferred from the Hebrew tradition, which attributes the invention of this ornament to Tubal-Cain, the "instructor of every artificer in brass and iron." The barbaric lover, in choosing a token for his mistress, was doubtless actuated, like the lover of to-day, by the wish to be kept in remembrance, and the proverbial saying, "Out of sight, out of mind," being as true in savage as in civilized times, he sought for a memento which should be always in view, never laid aside, not in danger of being lost—which, in short, should become a part of herself, mutely reminding her of him, and presenting a silent remonstrance when her affections went astray. For the purposes of a love-gift, he could find nothing more suitable than the ring. And when the agonies of courtship finally settled into the steady troubles of matrimony, it was not remarkable that this token of affection should remain on the finger of the bride, or be removed, to be succeeded by another of a similar kind.

The uses of the finger-ring have been many and diverse. Originally purely for ornament, it became a signet for kings and a warrant for their messengers; to civil officers it was once an emblem of office, and to ecclesiastics an indispensable portion of the episcopal costume. It was once worn by physicians to prevent contagion, and by patients to cure disease; the timorous wore it as a charm against evil spirits, and the ambitious clung to it as a talisman, giving the wearer success over his enemies. But as a love-token, and a symbol of marriage, the use of the ring is so general, and of so long standing, as to dwarf into insignificance its employment in all other directions.

At what period it came into play as a recognized factor in the marriage ceremony, it is impossible to say. The Hebrews used it in very early ages, and probably borrowed the custom from the Egyptians, among whom the wedding-ring was known—a circle, in the language of hieroglyphics, being the symbol of eternity, and the embodiment of the circle readily symbolizing the hypothetical duration of wedded love. The Greeks used wedding-rings, so did the Romans, both putting them on the forefinger—by-the-way, a practice followed by the mediæval painters, many of whom represent the Virgin's ring on her forefinger. In the East, where the popular estimate of woman is low, the use of the wedding-ring has not been common, though occasionally the favorite wife of an Oriental monarch would receive from her master a ring as a mark of his favor. The conclusion, therefore, is safe that, with increase of respect for the institution of marriage, come also increased respect for and use of the ring as a token of the alliance.

During a part of the middle ages, this respect showed itself in a peculiar way, custom demanding that the wedding-ring should cost as much as the bridegroom could afford to pay; and there are records in Germany and France, during the fourteenth and fifteenth centuries, of many large investments made in this direction by grooms eager to conciliate their brides and be in the fashion. The revulsion made the ring what we now have, a plain gold circlet; though, by a compromise, the engagement-ring may be as costly as fancy dictates or means permit.

The materials of which wedding-rings have been composed are as diverse as the nations which have used the ring. The British Museum has rings of bone and of hard wood, found in the Swiss lakes; on one of the bone rings is traced a heart, giving antiquaries reason to believe that the ring was a pledge of affection, if not a wedding-ring. The same museum has rings from all parts of the earth—of bone, ivory, copper, brass, lead, tin, iron, silver, gold, and some of a composite of several of these metals. One ivory ring, from an Egyptian tomb, bears two clasped hands; an iron ring, having the design of a hand closing over a heart, once graced the hand of a Roman matron; while the inscriptions on many others make it certain that they were wedding-rings.

The use of many different materials in the construction of these wedding-rings does not indicate capricious changes of fashion, for it should be remembered that museums and collections of antiquities comprise specimens of many ages and of widely-separated lands, but there is no doubt that fashion has sometimes had an influence in determining the style and material of the ring. For instance: during the latter part of the sixteenth century a fashion for some time prevailed in France of making the wedding-ring consist of several links fastened together in such a way as to seem but one. Sometimes there were three, two links having graven hands and the third a heart, the union of the three in the proper position clasping the hands over the heart. During the palmy days of astrology, there was quite a fashion in Germany of wedding-rings engraved with astronomical and astrological characters, the horoscopes of both the contracting parties being sometimes indicated in the setting of the ring. That being also the golden age of the quack doctor, wedding-rings were often made with a cavity to contain medical preparations or charms to preserve or restore health or avert evil. After the Crusades had set Europe in a flame, a practice became common in France, Germany, and England, of wearing rings the setting of which was a tiny fragment of wood from the true cross, and many of these rings are still preserved in the cabinets and museums of Europe. Ass-hoof rings were, in the seventeenth century, very popular among the Spanish peasants as a cure for epilepsy; and such a ring, made, it was said, from the hoof of the ass which carried Christ into Jerusalem, was used in a wedding in a country church near Madrid in 1881!

But when the ring was not plain, precious stones of some kind constituted the settings; and when the selection of the stone was in question, the dominance of fashion was absolute. In the fourteenth century, a fanciful Italian writer on the mystic arts set forth the virtues of the various gems, indicating also the month in which it was proper to wear particular stones in order to secure the best result. The idea took, and for some time it was the fashion in several Italian cities to have the precious stone of the ring determined by the month in which the bride was born. If in January, the stone was a garnet, believed to have the power of winning the wearer friends wherever she went. If in February, her ring was set with an amethyst, which not only promoted in her the quality of sincerity, but protected her from poison and from slanderous tongues. The blood-stone was for March, making her wise, and enabling her with patience to bear domestic cares; the diamond for April, keeping her heart innocent and pure so long as she wore the gem. An emerald for May made her a happy wife; while an agate, for June, gave her health and protection from fairies and ghosts. If born in July, the stone was a ruby, which tended to keep her free from jealousy of her husband; while in August, the sardonyx made her happy in the maternal relation. In September, a sapphire was the proper stone, it preventing quarrels between the wedded pair; in October, a carbuncle was chosen, to promote her love of home. The November-born bride wore a topaz, it having the gift of making her truthful and obedient to her husband; while in December the turquoise insured her faithfulness. Among the German country-folk, the last-named stone is to the present day used as a setting for the betrothal-ring, and, so long as it retains its color, is believed to indicate the constancy of the wearer.

From Italy this fanciful notion spread to France, and French bridegrooms would sometimes insure themselves against a bad matrimonial bargain, and, as far as they could, guarantee to their brides a variety of good qualities, by presenting twelve rings, one for each month, with occasionally one or two extra as special charms. However, this extravagance in the number of rings used at weddings is not a solitary instance, for the use of several rings at the marriage ceremony has often been known. Four rings placed on her hand at her marriage could not keep Mary Stuart faithful to Darnley; and the annals of European courts record many instances similar, both as to the rings and to the result. The Greek Church uses two rings, one of gold, the other of silver; while in some districts of Spain and Portugal, three rings are placed, one at a time, on the fingers of the bride, as the words, "In the name of the Father, and of the Son, and of the Holy Ghost," are pronounced.

Fashion has also determined, not only the style of the wedding-ring, but the finger on which it is to be worn; and so capriciously has custom varied, that the symbol of matrimony has traveled from the thumb to the fourth finger, where it now reposes. In the time of Elizabeth, it was customary, both in England and on the Continent, for ladies to wear rings on the thumb, and several of her rings now shown in the British Museum, from their size, must have been thumb-rings. That the practice of wearing thumb-rings extended to the case of married ladies and their wedding-rings, is amply attested, not only by allusions in contemporary literature, but by the portraits of matrons of that age, a great many, where the hands are shown, displaying the wedding-ring on the left thumb. In the time of Charles II, the ring seems to have found lodgment on the forefinger, sometimes on the middle finger, occasionally on the third finger also, and, by the time George I came to the throne, the third finger was recognized as the proper place for it, not universally, however, for William Jones in his treatise on rings, declares that even then the thumb was the favorite place for the wedding-ring, and gives instances of the ring being made of large size, and, although placed on the third finger at the ceremony, immediately afterward removed to the thumb.

An English work on etiquette, published in 1732, says it is for the bride to choose on which finger the wedding-ring shall be placed. It further states that some prefer the thumb, since it is the strongest and most important member of the hand; others, the index-finger, because at its base lies the mount of Jupiter, indicating the noble aspirations; others, the middle finger, because it is the longest of the four; and others, again, the fourth finger, because a "vein proceeds from it to the heart."

The "British Apollo," however, decides the proper place of the ring to be the fourth finger, not because it is nearer the heat than the others, but because on it the ring is less liable to injury. The same authority prefers the left hand to the right. The right hand is the emblem of authority, the left of submission, and the position of the ring on the left hand of the bride indicates her subjection to her husband. A curious exception to the rule placing the ring on the left hand is, however, seen in the usage of the Greek Church, which puts the rings on the right hand.

As the symbol of matrimony, it is not strange that many of the superstitious fancies which have arisen in connection with the wedding should cluster about the ring. Dreaming on a bit of wedding-cake is common among American young ladies; but they should be informed that, for the dreaming to be properly done, the piece of cake thus brought into service should be passed through the wedding-ring, for so it is done in Yorkshire, Wales, and Brittany, in which localities the custom has been observed from time immemorial. The Russian peasantry not only invest the cake with wonderful qualities by touching it with the two rings used in the ceremony, but deem that water in which the rings have been dipped has certain curious beneficial properties.

In many country districts of Great Britain it is believed that a marriage is not binding on either party unless a ring is used; hence, curtain-rings, the church-key, and other substitutes, including a ring cut from a finger of the bride's glove, have been mentioned as devices to meet an emergency, when a ring of the proper kind could not be procured in time. In parts of Ireland, however, there is a current belief that a ring of gold must be used, and jewelers in the country towns not infrequently hire gold rings to peasants, to be returned after the ceremony.

Blessing the ring gives it no small share of sanctity, and old missals contain explicit directions as to the manner in which this ceremony must be carried out. In the church-service as performed in the villages of England, the ring is frequently placed in the missal, the practice being, no doubt, a relic of the blessing once thought indispensable. The German peasant-women continue to wear the wedding-ring of the first husband, even after a second marriage, and a recent book of German travels mentions a peasant wearing, at one time, the wedding-rings of four "late lamenteds." An instance is known of a woman of German birth, who, after the death of her husband in a Western State, had the misfortune to lose her ring. She at once bought another, had it blessed, and wore it instead of the former, deeming it unlucky to be without a wedding-ring. Among the same class of people, stealing a wedding-ring is thought to bring evil on the thief, while breaking the emblem of marriage is a sure sign of speedy death to one or both of the contracting parties.

THE CHEMISTRY OF "OYSTER-FATTENING."

By W. O. ATWATER,

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NOT every lover of the oyster knows that the size and plumpness which are so highly prized in the great American bivalve, and which are so attractive in specimens on the half-shell or in the stew as to lead the average man to pay a considerable extra price for extra size, are not entirely natural; and even those who do know that the majority of the oysters in the market are artificially swollen by introducing water into the tissues are not all aware that the process by which this is done is closely analogous to that by which the food in our own bodies is conveyed through the walls of the stomach and other parts of the digestive apparatus and poured into the blood and lymph to do its work of nourishment.

Physiologists are, I believe, agreed that the passage of the digested food through the walls of the alimentary canal in man and other animals is, in large part, due to osmose or dialysis, and that the operation of this physical law is a very common one in the animal body. But the quantitative study of the chemical changes involved is generally rendered difficult or impossible by the very fact of their taking place in living animals where the application of chemical analysis is impossible. An opportunity is, however, offered by the oyster, which, since it lives in water and has a body so constituted as to readily permit the inflow and outflow of water and solutions of salts, may be easily used for experiments. The results of the experiments have a practical as well as scientific interest, since they confirm the common explanation of the increase in bulk of oysters by "floating," and show that it is essentially a process of watering in which the bulk is increased without any corresponding increase, but rather, if anything, a loss of nutritive material.*

It is a common practice of oyster-dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time—forty-eight hours, more or less—in fresh or brackish water, in order, as the oyster-men say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The belief is common among oyster-men that this "fattening" is due to an actual gain of flesh and fat, and that the nutritive value of the oyster is increased by the process. A moment's consideration of the chemistry and physiology of the subject will make it clear, not only that such an increase of tissue-substance in so short a time and with such scanty food-supply is out of the question, but that the increase of volume and weight of the bodies of the oysters is just what would be expected from the osmose which would naturally take place between the contents of the bodies of the oysters as taken from salt water and the fresh or brackish water in which they are floated.

If we fill a bladder with salt water, and then put it into fresh water, the salt water will gradually work its way out through the pores of the bladder, and, at the same time, the fresher water will enter the bladder ; and, further, the fresh water will go in much more rapidly than the salt water goes out. The result will be that the amount of water in the bladder will be increased. The bladder will swell by taking up more water than it loses, while at the same time it loses a portion of the salt.

It does this in obedience to a physical law, to which the terms osmose and dialysis are applied. In accordance with this law, if a membranous sac holding salts in solution is immersed in a more dilute solution, or in pure water, the more concentrated solution will pass out, and at the same time the water, or more dilute solution, will pass in, and more rapidly. The escape of the concentrated and entrance of the dilute solution will be, in general, the more rapid the greater the difference in concentration and the higher the temperature of the two solutions. After the osmose has proceeded for a time, the two solutions will become equally diluted. When this equilibrium between

* The following statements are adapted from a paper presented to the last meeting of the American Fisheries Association.

the two is reached, the osmose will stop. If the sac which has become distended is elastic, it will, after osmose has ceased, tend to come back to its normal size, the extra quantity of solution which it has received being driven out again.

We should expect these principles to apply to the oyster. Roughly speaking, the body of the animal may be regarded as a collection of membranous sacs. It seems entirely reasonable to suppose that the intercellular spaces, and probably the cells of the body, would be impregnated with the salts of the sea-water in which the animal lives; and this supposition is confirmed by the large quantity of mineral salts which the body is found by analysis to contain, and which amount, in some cases, to over fourteen per cent of the water-free substance of the body.

It seems equally reasonable to believe that osmose would take place through both the outer coating of the body and the cell-walls of the animal's body. As long as the oyster stays in the salt water, the solution of salts within its body would naturally be in equilibrium with the water outside. When the animal is brought into fresh or brackish water, i. e., into a more dilute solution, we should expect the salts in the more concentrated solution within its body to pass out, and a larger amount of fresh water to enter, and produce just such a distention as actually takes place in the floating. If this assumption is correct, we should expect that the osmose would be the more rapid the less the amount of salts in the surrounding water, that it would proceed more rapidly in warm and more slowly in cold water; that it would take place whether the body of the animal is left in the shell or is previously removed from it; that the quantity of salts would be greatly reduced in floating; and that, if it were left in the water after the maximum distention had been reached, the imbibed water would pass out again, and the oyster would be reduced to its original size. Just such is actually the case. Oyster-men find that the oysters "fatten" much more quickly in fresh than in brackish water; warmth is so favorable to the process that it is said to be sometimes found profitable to warm artificially the water in which the oysters are floated. Although oysters are generally floated in the shell, the same effect is very commonly obtained by adding fresh water to the oysters after they have been taken out of the shell; indeed, I am told that this is a by no means unusual practice of retail dealers. Oysters lose much of their salty flavor in floating, and it is a common experience of oyster-men that, if the "fattened" oysters are left too long on the floats, they become "lean" again.

This exact agreement of theory and fact might seem to warrant the conclusion that the actual changes in the so-called fattening of oysters in floating are essentially gain of water and loss of salts. The absolute proof, however, is to be sought in chemical analysis. In the course of an investigation conducted under the auspices of the United

States Fish Commission, and which included examinations of a number of specimens of oysters and other shell-fish, I have improved the opportunity to test this matter by some analyses of oysters before and after floating. The results of the investigation are to be given in detail in one of the publications of the Commission,* in which the principles involved and some side-issues of the experiments will be discussed. I give here the main results, prefacing by brief accounts of the process of "floating" oysters as actually practiced by oyster-men.

The following very apposite statements † are by Professor Persifor Frazer, Jr., who attributes the changes mentioned to dialytic action:

The oysters brought to our large markets on the Atlantic seaboard are generally first subjected to a process of "laying out," which consists in placing them for a short time in fresher water than that from which they have been taken.

Persons who are fond of this animal as an article of food, know how much the "fresh" exceed the "salts" in size and consistency. The "Morris Coves" of this city [Philadelphia], while very insipid, are the plumpest bivalves brought to market. On the other hand, the "Absecoms" and "Brigantines," while of a better flavor (to those who prefer salt oysters), are invariably lean compared to their transplanted rivals, as also are the "Cape Mays," though, for some reason, not to the same extent.

The most experienced oyster-dealers inform me that the time for allowing the salt oysters taken from the sea-coast to lie out varies, but is seldom over two or three days. At the end of this time the maximum plumpness is attained, and beyond this the oyster becomes lean again, besides having lost in flavor.

The subjoined statements by Lieutenant J. A. Ryder are interesting in this connection. They are taken from a letter to Professor Baird, United States Commissioner of Fish and Fisheries, on "Floats for the So-called Fattening of Oysters": ‡

The simplest and most practical structures of the kind which I have seen are the storage and fattening floats used by Mr. Conger, of Franklin City, Maryland, and now in use by all the shippers and planters in the vicinity of Chincoteague Bay. I have been informed that similar structures, or rather structures serving similar purposes, are in use on the oyster-beds along the shore of Staten Island, New York.

It is probably a fact that in all these contrivances they take advantage of the effect produced by fresher water upon oysters which have been taken from slightly salter water. The planters of Chincoteague call this "plumping the oysters for market." It does not mean that the oysters are augmented in volume by the addition of substantial matter, such as occurs during the actual appropriation of food, but only that the vascular spaces and vessels in the animals are filled with a larger relative amount of water due to endosmose. It is a dealer's trick to give his produce a better appearance in the market, and as such I do not think deserves encouragement, but rather exposure.

* A detailed account is also to appear soon in the "Zeitschrift für Biologie."

† "Note on Dialysis in Oyster-Culture," in "Proceedings of Philadelphia Academy of Sciences," 1875, p. 472.

‡ "Bulletin of the United States Fish Commission," 1884, p. 302.

Mr. Conger has actually resorted to warming fresh water to 60° Fahr. in winter, by steam-pipes running underneath the wooden inclosure surrounding the "fattening" or "plumping" float. One good "drink," as he expressed himself to me, renders the animals fit for sale and of better appearance.

Conger's floats are simply a pair of windlasses supported by two pairs of piles driven into the bottom. Chains or ropes which wind upon the windlasses pass down to a pair of cross-pieces, upon which the float rests, which has a perforated or strong slat bottom, and a rim eighteen inches to two feet high. These floats I should think are about eight feet wide and sixteen feet long, perhaps twenty. These structures are usually built alongside the wharves of the packing and shipping houses, and are really a great convenience in conducting the work.

Elsewhere Lieutenant Ryder speaks of the floats thus:

The diaphragm itself was constructed of boards perforated with auger-holes, and lined on the inside with gunny-cloth or sacking; and the space between the perforated boards was filled with sharp, clean sand. The space between the boards was about two inches; through this the tide ebbed and flowed, giving a rise and fall of from four to six inches during the interval between successive tides.

Mr. F. T. Lane, of New Haven, Connecticut, writes as follows about the method of floating practiced by himself, and, as I understand, by other New Haven oyster-growers:

We do not always leave them two days in the floats—as a rule, only one day. We put them into brackish water and take them out at low water or in the last of the falling tide, as then the water is the freshest and the oysters are at their best. As it is not convenient for us to put them into the floats and take them out the same day, we do not want the water too fresh. On one occasion, wishing to know what the result would be of putting the oysters into water that was quite fresh, I had one of my floats taken up the river, half a mile farther than where we commonly use them, and one hundred bushels of oysters put into it at high water and taken out at low water. They were in the water from six to seven hours and came out very nice, fully as good as those floated twenty-four hours in the brackish water. It was a warm day, and the water was warm. Under these conditions they will drink very quickly. I have seen them open their shells in ten minutes after they were put into the water.

For the following valuable information I am indebted to Mr. R. G. Pike, chairman of the Board of Shell-fish Commissioners of Connecticut:

Connecticut oysters, when brought from their beds in the salt waters of Long Island Sound, are seldom sent to market before they have been subjected to more or less manipulation. As soon as possible after being gathered, they are deposited in shallow-tide rivers where the water is more or less brackish, and are left there from one to four days; the time varying according to the temperature of the season, the saltness of the oysters, and the freshening quality of the water. Generally two tides are sufficient for the two "good drinks" which the oyster-men say they should always have.

This "floating," as it is called, results in cleaning out and freshening the oysters, and increasing their bulk; or, as many oyster-men confidently assert, "fattening" them. If the weather is warm, they will take a "drink" immediately, if not disturbed; but if the weather is cold, they will wait sometimes ten or twelve hours before opening their valves. Good fat oysters generally yield five quarts of solid meat to the bushel; but, after floating two tides or more, they will measure six quarts to the bushel. After they have been properly floated they are taken from the shell—and as soon as the liquor is all strained off, they are washed in cold fresh water—and are then packed for market. In warm weather they are put into the water with ice, and are also packed with ice for shipping. Water increases their bulk by absorption and by mixing with the liquor on the surface of the oysters. The salter the oyster the more water it absorbs. In twelve hours one gallon of oysters, with their juices strained out, will take in a pint of water; but when very salt and dry, they have been known to absorb a pint in three hours.

Water always thickens the natural juices that adhere to the surface of the oyster, and makes them slimy. If too much water is added, the oyster loses its plumpness and firmness and becomes watery and flabby.

Oysters that have been floated bear transportation in the shell much better than when shipped directly from their beds. Oysters, too, that are taken from their shells and packed in all their native juices spoil much sooner than when their juices are strained out and the meats are washed in fresh cold water.

Long clams are not floated, but round clams are. But both, when shucked, are washed in fresh water. This cleanses them of mud, sand, and excess of salt, increases their bulk, and improves their flavor. After washing they will keep much longer without risk of spoiling. If the salt is left in them, as they come from their native beds, their liquor will ferment, and they will quickly spoil.

The above facts are gathered from the most intelligent men in the shell-fish business in Connecticut—men who have had many years' experience in gathering oysters and clams, and preparing them for home and foreign consumption. They are all agreed that by judicious floating in the shell, and by washing and soaking when out of the shell, the oyster and the clam increase in bulk and improve in quality and flavor. We will not presume to say that this increased bulk is anything more than a mechanical distention of the organs and the cellular tissues of the oyster by water; or that its improved flavor is not due simply to a loss of bitter sea-salt dissolved out by the water. Many intelligent cultivators are confident that the increase in bulk is a growth of fat; while just as many, of equal intelligence, declare that it is mere "bloat" or distention, akin to that of a dry sponge when plunged into the water. The exact nature of the change the chemist alone can determine.

The following experiments were made with oysters courteously supplied by Mr. Lane, a communication from whom was just quoted. The oysters had been brought from the James and Potomac Rivers, and "planted" in the beds in New Haven Harbor (Long Island Sound) in April, and were taken for analysis in the following November.

Two experiments were made. The plan of each experiment consisted in analyzing two lots of oysters, of which both had been taken from the same bed at the same time, but one had been "floated" while the other had not. For each of the two experiments, Mr. Lane selected, from a boat-load of oysters as they were taken from the salt water, a number, about three dozen, which fairly represented the whole boat-load. The remainder were taken to the brackish water of a stream emptying into the bay and kept upon the floats for forty-eight hours, this being the usual practice in the floating of oysters in this region. At the end of that time, the oysters were taken from the floats, and a number fairly representing the whole were selected as before. Two lots, one floated and the other not floated, were thus taken from each of two different beds. The four lots were brought to our laboratory for analysis.

The specimens as received at the laboratory were weighed. Thereupon, the shell-contents were taken out, and the shells and shell-contents both weighed. The solid and liquid portions of the shell-contents —i. e., the flesh or "solids" and liquor or "liquids"—were weighed separately, and then analyzed. We thus had, for each lot, the weights of flesh and liquids which, together made the weight of the total shell-contents, and the weight of the shells, which with that of the shell-contents made the weight of the whole specimens. We also had, from the analyses, the percentages of water, nutritive ingredients, salts, etc., in the flesh and in the liquids. From these data the calculations were made of the changes which took place in floating. For the details, which are somewhat extended, I may refer to the publication mentioned above. It will suffice here to give only the main results. It is assumed that the changes in the composition of the body of the animal, due to respiration, nutrition, excretion, etc., during the floating would be too small to be taken into account.

The body of the animal may be regarded as made up of water and so-called water-free substance. The water-free substance contains the nutritive ingredients or "nutrients." These may be divided into four classes: 1. Protein compounds, the so-called "flesh-formers," which contain nitrogen* ; 2. Fatty substances, classed as fats ; 3. Carbohydrates ; 4. Mineral salts. These constituents of the flesh of oysters have been but little studied. It is customary to assume them to be similar to the corresponding compounds of other food-materials, but very probably the difference, if known, might prove to be important. The mineral matters especially, which are very large in amount, appear to include considerable of the salts of sea-water. Of the nature of the ingredients of the liquids but little is known. They consist mainly of water and salts and the amounts of their ingredients which are commonly reckoned as protein, fats, and carbohydrates, are very small, so that whatever error there may be in classing them with the ordinary nutrients of food, it will not very seriously affect the estimates of nutritive values.

During the sojourn in brackish water, both the flesh (body) and the liquid portion of the shell-contents of the oysters suffered more or less alterations in composition. In order to show clearly what the principal changes, as shown by the chemical analyses, were, it may per-

* The protein is estimated in the usual way by multiplying the nitrogen by 6·25.

haps be permissible to cite a few of the statistics. I give more details than would perhaps be appropriate in these pages, were it not for the novelty of the results, and the importance of their bearing upon the physiology of absorption of nutritive material in our bodies as well as upon the nutritive value of the oysters.

The changes in the constituents of the body ("flesh") were mainly such as would be caused by osmose, though there were indications of secretion of nitrogenous matters and, especially, of fats, which are not so easily explained by osmose. This I will speak of later.

The amounts of gain and loss of constituents which the bodies of the oysters experienced may be estimated either by comparing the percentages found by analysis before and after dialysis, or by comparing the absolute weight of a given quantity of flesh and the weights of each of its ingredients before, with the weights of the same flesh and of its ingredients after, dialysis. For the estimate by the first method we have simply to compare the results of the analyses of the floated and the not-floated specimens. Taking the averages of the two experiments, it appears that—

The percentages of—	Before dialysis.		After dialysis
Water rose from	77·9	to	82·4
Water-free substance fell from	22·1	"	17·6
Total flesh	100·0		100·0
Protein fell from	10·5	to	8·9
Fat fell from	2·5	"	1·9
Carbohydrates, etc., fell from	6·9	"	5·2
Mineral salts fell from	2·2	"	1·6
Total water-free substance in flesh	22·1		17·6

There was, accordingly, a gain in the percentage of water and a loss in that of each of the ingredients of the water-free substance. This accords exactly with the supposition that during the floating the flesh gained water and lost salts and other ingredients.

It will be more to the point to note the absolute increase and decrease in amounts of flesh and its constituents—in other words, the absolute gain or loss of each in the floating. Estimates by this method have been made and explained in the detailed accounts referred to. They make it appear that 100 grammes of the flesh as it came from the salt water was increased by floating, in one specimen, to 120·9, and in the other to 113·4 grammes. This is equivalent to saying that the two specimens of flesh gained in the floating, respectively, 20·9 and 13·4 per cent, or, on the average, 17·3 per cent of their original weight. By the same estimates the water-free substance in the 100 grammes of flesh before the floating weighed, on the average, 22·1 grammes, while that of the same flesh after floating weighed only 20·6 grammes, making a loss of 1·5 gramme or 6·6 per cent of the 22·1 grammes which the water-free substance weighed before dialysis. The main results of the two experiments thus computed, may be stated as follows:

In the "floating" of 100 grammes of flesh (body) of the oysters—

The weight of—	Before dialysis.			After dialysis.	
Water rose from	77·9	grammes	to	96·6	grammes.
Water-free substance fell from	22·1	"	"	20·6	"
Whole flesh rose from	100·0	"	"	117·2	"
Protein was assumed to remain the same.	10·5	"	"	10·5	"
Fats fell from	2·5	"	"	2·3	"
Carbohydrates, etc., fell from	6·9	"	"	6·0	"
Mineral salts fell from	2·2	"	"	1·8	"
Total	22·1	"		20·6	"

In brief, according to these computations, the flesh lost between one sixth and one seventh of its mineral salts, one eighth of its carbohydrates, and one twelfth of its fats, but gained enough water to make up this loss and to increase its whole weight by an amount equal to from one seventh to one fifth of the original weight. Assuming the loss of nutritive value to be measured by the carbohydrates and fats which escaped, it would amount to about one tenth of the whole. That is to say, the total nutritive materials were one tenth less after floating than before.

In the liquid portion of the shell-contents, the percentage of water rose and that of the water-free substance fell in a very marked degree. But while the whole percentage of water-free substance was diminished, that of both protein and of carbohydrates rose slightly (the amount of fats was too small to be taken into account), so that the falling off was all in the mineral salts. The experiments do not show the exact increase or decrease in the total amounts of the liquids and their constituents, so that it is impossible to say with entire certainty whether there was or was not an actual gain of protein or fats or carbohydrates. It would seem extremely probable, however, that the liquids received and retained small quantities of these materials from the flesh (bodies) of the animals.

The apparent increase of protein and other materials belonging to the body in the liquids, though slight, is very interesting. I must refer to the detailed account of the experiments for the discussion of it and of the changes in composition of the liquids. The point is that if the changes in composition of the oysters in floating were due to osmose or dialysis alone, we should expect simply a gain of water and loss of salts (and perhaps of soluble carbohydrates). But the flesh seems to have lost a little carbohydrates and fats, and probably protein also, along with the salts, while it was absorbing water, the liquids at the same time gaining more or less of protein and carbohydrates. A way in which this may have come about is suggested by my colleague, Professor Conn, who calls attention to the fact that some mollusks, when irritated, produce an extremely abundant secretion of mucus or "slime"—so much, indeed, as to sometimes render a small quantity of water in which the animals may be confined, quite sensibly gelatinous. He suggests that the change to fresh water may induce such a secretion of mucus, and perhaps of carbohydrates and fats as well, as would account for the increase of these substances in the liquids. The observation of oyster-dealers that "water always thickens the natural juices that adhere to the surface of the oyster and makes it slimy," accords with Professor Conn's statement.

If such secretion did take place, the flesh must probably have lost a little protein during the floating. The estimates of absolute gain and loss of weight of flesh and ingredients are based upon the assumption that the quantity of protein was unaltered in floating. If protein was given off, therefore, the estimates are wrong. But the quantity of protein secreted and the consequent error must be, at most, very slight. If there is an error, its effect would be to make the quantities of nutrients after floating appear larger than they really were. In other words, if the error were corrected, it would make the loss of nutritive material in floating greater than it appears to be in the figures above given.

The experiments might have been so conducted as to decide this question of the exact gain and loss of weight of each material in the oysters. It would have been necessary to simply take a larger number in each lot before and after floating, and be certain that the number, weight, and bulk were the same in the floated and not-floated lots of each experiment. For instance, we might, in each experiment, carefully select two lots of, say, a bushel each, as taken from the beds; have the number of oysters the same in each bushel, as an additional assurance that the two lots were alike; float one bushel, and weigh and analyze both. A few experiments of this sort made under different conditions of time, temperature, kind, and age of oysters, etc., would give very reliable and valuable data. Unfortunately, the means at my disposal did not permit so thorough experiments. I am persuaded, however, that the results of such series of trials, if they could be made—and I wish they might be—would be very similar to those of the trials here reported.

It is very interesting to note that these processes of both osmose and secretion which we have been considering in the body of the oyster are apparently very similar to processes which go on in our own bodies—namely, those by which our food, after it is digested, finds its way through the walls of the stomach and other parts of the alimentary canal into the blood, to be used for nourishment. Physiologists tell us that the passage of the digested materials through the walls of the canal is in part merely a physical action, due to osmose, but that it is in part dependent upon a special activity of the cells of the villi. In like manner, the changes in the composition of the oyster, if the above explanation is correct, are caused partly by osmose, and partly by special secretive action, the cell-walls and outer coat of the body of the oyster corresponding to the walls of the alimentary canal in the human body. The forms of vital activity in the two cases are different, but osmose is concerned in both.

The main points here urged may be very briefly summarized:

1. In the floating of oysters for the market, a practice which is very general, and is also used for other shell-fish, the animals are either taken direct from the beds in salt water, and kept for a time in fresher (brackish) water before they are opened, or water is added to the shell-contents after they are taken out of the shell. When thus treated, the body of the animal takes up water and at the same time parts with some of its salts, while small quantities of the nutritive ingredients also escape. The oysters thus become more plump, and increase considerably in bulk and weight, but the quantity of nutritive material, so far from increasing, suffers a slight loss.

2. In the experiments here reported, the increase in bulk and weight was from one eighth to one fifth of the original amounts. This is about the same as is said to occur in the ordinary practice of floating or "fattening" for the market. According to this, five quarts of oysters in their natural condition would take up water enough in "floating" to increase their bulk to nearly or quite six quarts, but the six quarts of floated oysters would contain about one tenth less of actual nutrients than the five quarts not floated.

3. The gain of water and loss of salts are evidently due to osmose. The more concentrated solution of salts in the body of the animal, as taken from salt water, passes into the more dilute solution (fresher water) in which it is immersed, while a larger amount of the fresher water at the same time enters the body. But part of the exchange, and especially that by which other materials, carbohydrates, protein, etc., are given off in small quantities, is more probably due to a special secretory action.

4. The flavor of oysters is often much improved by the removal of the salts in floating, and they are said to bear transporting and to keep better. When, therefore, the oyster-man takes "good fat oysters" which "yield five quarts of solid meat to the bushel" and floats them so that "they will yield six quarts to the bushel," and thus has an extra quart, and that a quart of the largest and highest-priced oysters, to sell, he offers his customers no more nutritive material—indeed, a trifle less—in the six quarts than he would have done in the five quarts if he had not floated them. But many people prefer the taste of the floated oysters, and since they buy them more for the flavor than for the nutriment (at ordinary prices, the nutrients in oysters cost the buyer from three to five times as much as similar nutrients in the better kinds of meat), doubtless very few customers would complain if they understood all the facts. And considering that the practice is

very general and the prices are regulated by free competition, the watering of oysters by floating in the shell is, perhaps, less reprehensible than at first thought it might seem. This phase of the question, however, it is not the purpose of this article to discuss.

5. From the standpoint of chemical physiology the most interesting outcome of the experiments is the very interesting parallelism they show between the processes by which the salts and other materials pass from within the body to the surrounding medium and those by which the digested materials of the food in man and other animals are conveyed through the walls of the alimentary canal into the blood and lymph to serve their purposes in nutrition. In each case the process seems to be due in part to osmose (dialysis) and in part to a special function of the organs.

To recapitulate still more briefly: The oysters in "floating" in fresher water, for some hours after they were taken from the beds in salt water, as is commonly done in preparing them for the market, gained from one eighth to one fifth in bulk and weight by taking up water, but at the same time lost about one tenth of their nutritive material. They did this by processes essentially similar to those which go on in our own bodies, and by which the digested food passes from the alimentary canal into the blood, to be used for nourishment.

GEIKIE ON THE TEACHING OF GEOGRAPHY.*

By FREDERIK A. FERNALD.

GEOGRAPHY has been the last of the sciences which are studied in school to be affected by the modern demand that science shall be taught according to the scientific method. It is extremely important that this method of teaching the description of the earth should speedily become general, for most pupils study geography, and those who leave school at an early age may not otherwise obtain that quickening of the powers of observation and inference which the study of science gives.

Furthermore, to quote Professor Geikie, "Geography, in the wide and true sense of the word, offers admirable scope for this kind of training. It may be begun on the very threshold of school-life, and may be pursued in ever-increasing fullness of detail and breadth of view up to the end of that time. No other subject can for a moment be compared with it in this respect. It serves as common ground on which the claims of literature, history, and science may be reconciled." In order to aid teachers in leading their pupils into the study of

* "The Teaching of Geography. Suggestions regarding Principles and Methods for the Use of Teachers." By Archibald Geikie, LL. D., F. R. S. London and New York: Macmillan & Co. Pp. 202. Price, 60 cents.

geography by the natural method, Professor Geikie has written a little manual, which broadly sketches the plan to be adopted. The following paragraphs embody the principal features of this plan:

To begin the teaching of geography with formal lessons on the shape of the earth, parallels, meridians, equator, poles, and the rest, is to start at the wrong end. To the average boy or girl of six or seven years these details have no meaning and no interest. Their introduction on the very threshold of geographical instruction is a characteristic feature of our system, or rather want of system, in this department of education. They are very generally placed at the beginning of our class-books, and being there, they form, as a matter of course, the subjects of the first lessons usually given in geography. An altogether inordinate value is set by us upon class-books. Instead of serving, as they ought, merely to furnish the text for the fuller and more interesting exposition of the teacher, these books are for the most part slavishly followed.

The lesson of the day too often consists in the repetition by rote of so many sentences or paragraphs from the class-book, which are seldom expanded or made more attractive and intelligible by elucidation on the part of the teacher. Such instruction, if it may be so called, is bad for the teacher and worse for the taught. It is especially pernicious to the children in the earlier stages of their geographical studies, for it tortures their memories and brings no compensating advantage. It fosters idleness and listlessness on the part of the teacher, who, instead of exerting his faculties to invest the subject with a living interest, becomes for the time a mere machine, mechanically acting within the limits prescribed in the class-book.

In dealing with the young we should try to feel ourselves young again, to see things as they are seen by young eyes, to realize the difficulties that lie in the way of children's appreciation of the world around them, to be filled with an abounding sympathy which subdues all impatience on our side, and calls out on the side of the children their confidence and affection. Mutual sympathy and esteem are a pledge of enduring success. To cement this bond of union between teacher and taught there should be no set tasks for some considerable time. The lessons ought rather to be pleasant conversations about familiar things. The pupils should be asked questions such as they can readily answer, and the answering of which causes them to reflect, and gives them confidence in themselves and freedom with the teacher. The objects in the school-room, in the play-ground, on the road to school, should be made use of as subjects for such questionings, with the aim of drawing out the knowledge acquired by the pupils from their own observation. Every question should be one which requires for its answer that the children have actually seen something with their own eyes and have taken mental note of it. The putting of such questions stimulates the observing faculty, and not unfrequently gives a chance of distinction to boys and girls whose capabilities are not well tested by the ordinary lessons of school.

But, while laying his foundations broadly in this way and widening the knowledge of his pupils, the teacher will do well to keep clearly before him some definite goal toward which the discipline of the elementary stage is to lead up. Probably no object can be suggested more fitting for this purpose than the thorough comprehension of a map. The power of understanding a map, and getting from it all the information it can afford, is an acquisition which lies at the base of all sound geographical progress. Yet how large a proportion, even of the educated part of the community, have only a limited and imperfect conception of the full meaning and uses of a map!

There is happily now a growing recognition of the principle that adequate geographical conceptions are best gained by observations made at the home locality. The school and its surroundings form the natural basis from which all subsequent geographical acquirement proceeds. Upon a groundwork of actual observation and measurement the young mind is led forward in a firm and steady progress. The school-room and play-ground serve as units from which an estimate is gradually formed of the relative proportions of more distant objects and places.

During infancy we learn that things differ in size and in distance from us. How much they differ in these respects is found out more slowly, if indeed discovered at all. Among the peasantry many adults may be met with who have hardly advanced a step beyond the infantile stage of perception. And even among those who consider themselves educated, it is sometimes ludicrous to see how absolutely untrained they are to judge with even an approach to accuracy of the relative sizes and distances of things. One of the most useful lessons, therefore, in the elementary part of geographical instruction, is to accustom the pupils to appreciate differences of size and proportion by actual measurement. The most convenient unit of measure to start with is the length of a pace, while the school-room is the most convenient place to try the first experiments in mensuration. By multiplying the measurements they have taken at school, the pupils will appreciate how far it is from school to their homes, what distance separates their village or town from the next, what is the size of their parish or county, and so on to the country as a whole, and eventually to the dimensions of the earth itself, and of planetary space.

If want of accuracy in judging of the dimensions of things is a common failing, not less prevalent is want of accuracy in judging of their relative positions, or what is called orientation. We begin in infancy with the difference between our right and left hands, and recognize things and places as lying to the right or left of us. But many of us hardly get beyond this rudimentary stage. It is almost incredible how helpless even educated people often are if asked to tell whether one place lies to the north or south of another. They know that in passing between them you go to the right or left, as the case may be, but there their power of localization ends. What is needed is greater quickness and precision in orientation, and this ought to be acquired from early training at school.

When some progress has been made in elementary geographical conceptions, the blackboard should be brought into increasing use. After the school-room, for example, has been paced, and its dimensions and proportions have been thus ascertained, its plan should be drawn on the board by the teacher, with the relative positions of door, windows, and fireplace. From this beginning, gradual steps may be taken until the pupils can themselves draw on the board and on their slates rough plans of the school and of the play-ground. At first it will be sufficient to aim only at a general resemblance of proportion. The great object is to teach the young minds to realize the relations between the actual boundaries and the artificial representations of them. To succeed in this is by no means so easy as might be thought; but success in it is absolutely necessary, and must be attained no matter at what expenditure of time and labor. When it has been achieved, efforts should next be made to depict the plan to scale, and with a nearer approach to correctness.

It is desirable to ascertain and arrange the conceptions that children already possess as to time. They know that day and night follow each other in unbroken succession. They further know that each day has a morning, a noon, and an evening. These and their other notions should be drawn from them by questioning, and the answers, corrected by the class (or by the master if no member of the class has the requisite information), should be methodically summarized and repeated in the simplest language, as the basis of actual experience from which the pupils are to advance to further acquisitions of knowledge.

In taking the school surroundings as the basis of instruction, the teacher will readily recognize that, while the principle of his method remains the same, its details must necessarily vary according to the circumstances of the locality. The two most obvious distinctions are those of town and country. In a town, illustrations of the political side of geography are most prominent; in the country, it is the physical side that especially invites attention. The teacher should from the first realize that some of the most valuable parts of the training his pupils can receive are not attainable within the walls of the class-room. Where practicable, he should himself take walks with his pupils, and direct their attention to the objects to be seen as they go. There are, no doubt, practical difficulties in the way of carrying out this method, but these are generally not insurmountable.

In all these lessons, the system of question and answer must be scrupulously followed. Anything approaching to a style of lecturing should be carefully avoided. Instead of appearing to discourse himself, the teacher should aim at obtaining clear, articulate expression of the knowledge and experience of the children. He may then judiciously sum up what has been gained during the lesson from the united experience of the whole class, and supplement it by filling in some of the more notable gaps. But the additions thus made by him to the common stock of acquirement should never be too preponderating a feature in the earlier lessons, and should come as naturally suggested by what has been obtained from the class.

It is often of advantage to let the lesson be suggested by some incident of the day, or something that has arrested notice since the previous lesson. The attention of the children is thereby riveted to the subject. They are ready to say all that they know about it, and eager to hear anything more which the teacher may tell them. A wet morning will profitably suggest a lesson on rain; the replenishing of the school-room fire with coal will furnish materials for another lesson, of a more advanced kind. The flitting of a butterfly through the open window of the school-room will suggest a lesson on insect-life, and give the teacher an opportunity of unfolding some of the wonders of the animal world and enforcing a reverence and sympathy for all living things. In short, his eye should be ever on the watch for materials on which he can train the observing and reflecting faculties of his scholars. If an incident likely to be of this useful kind should occur even in the midst of a lesson on another subject, he may profitably interrupt the work to direct attention to it that it may be distinctly seen, and he can afterward, at the proper time, return to the elucidation of it.

An observant teacher will not fail to notice that, long before children can understand or take any intelligent interest in the geography-lesson as ordinarily given in our schools, they are quite alive to the attractions of that large mass of phenomena embraced within the scope of what is called physical geography. They at first care little about the political boundaries or subdivisions of countries; but if you speak to them of the changes of the sky, the movements of the wind, the fall of rain, the nature of snow and frost, or of rivers, lakes, and glaciers, of waves and storms, of the soil and the plants that grow in it, of insects and birds and familiar quadrupeds, in short, of the outer world which they see around them from day to day, their attention is at once arrested. The subject is one that comes within the range of their own observation. And in education, the importance of connecting the subject of instruction with the personal experience of the pupils can hardly be overestimated. As the school district constitutes the basis from which, as far as possible, the pupils are to realize what the world is as a whole, early attention should be given to its natural features. Among these the configuration of the ground should claim special notice. In flat regions, it must obviously be less easy to find practical exemplifications of this branch of the subject; though, even there, observation of the flow of water will reveal differences of level, and determine the highest and lowest ground.

A knowledge of the great movements of the air we breathe, and of the general laws that govern these movements, ought obviously to form an elementary part of any liberal education. The subject has attractions for old and young, since it includes a consideration of many of the most familiar occurrences of every-day life. Variations of weather, changes of temperature and moisture, the gathering of clouds, the rise of winds and storms—these and many other phenomena, which have fixed our attention from infancy, ought not to be the objects of mere gaping wonder. They should be intelligently appreciated, and the due comprehension of them should be begun during the early years of school-life.

From the rainfall, the transition is natural and easy to the flow of water over the land. The part of the rain that runs off in runnels and brooks can readily be followed. Where a stream exists in the school locality it should be made the text for the lessons on the flow of rivers, and the action of running water upon the surface of the land. The portion of the rain that sinks underneath the surface is less easily followed. But if there are any springs in the neighborhood of the school, they may be made an effective means of explaining the underground circulation of water. They should be revisited at different seasons, more particularly after drought and after heavy rains, when any appreciable variation in the volume of water may be detected, and the relation of the outflow to the rainfall may be enforced. Should the school be situated near the sea, an inexhaustible field of illustrations may be found along the shore. The phenomenon of the tides, which elsewhere can only be more or less intelligently followed from diagram and description, can here be actually seen every day. Besides the tides, the formation of waves may be observed at the coast; also their action in wearing away the edge of the land in one part, and heaping up shingle and sand at another.

In our methods of geographical instruction it has been too much the practice to ignore the biological side of geography. Yet, if we think of it, the forms of the land, the nature and distribution of the soils, the variations of climate, the systems of drainage, and the other features of the surface of the earth, derive, after all, their chief interest for us from the way in which they determine the conditions under which the living plants and animals of a country exist and flourish. The flora and fauna include so much of what makes the earth habitable and pleasant to man, that the description of them may be regarded as the highest subdivision of geographical narrative which finds its goal or crown in the characteristics and operations of man himself. No description of a region, therefore, and no mode of geographical instruction can be looked upon as complete, which do not bring before us at least the more striking features in the general assemblage of plants and animals.

For the effective instruction of the young in that wide and important department of knowledge commonly but not very happily called political geography, the school locality forms an admirable center and starting-point. Such matters as the partitioning of the earth's surface into countries and parts of countries, the local names assigned to these subdivisions and to the natural features that diversify them, the position and growth of cities, towns, and villages, the distribution of population, the opening of communications by roads, canals, and railways, the distribution and increase of trades, manufactures, and commerce—these and other topics embraced within the same extensive subject can obviously be made at once intelligible and interesting if they are first considered with reference to the illustrations of them which the surroundings of school may supply.

The subjects treated of continuously and in logical sequence in the foregoing chapters need not, of course, be presented in such formal and methodical order to the pupils. As I have already insisted, they should be taught in a natural and spontaneous way. It is not, in the first instance, of such moment that any definite order should be followed, as that the subjects should be made attractive, and the interest of the pupils in them should be awakened and sustained. Whether the instruction has been given in a methodical or more desultory fashion, much varied information about the home locality will have been brought together. Before proceeding further, and enlarging the circle of vision by entering upon a wider geographical area beyond the personal acquaintance of the pupils, it will be found of great advantage to arrange and summarize this information. By so doing the teacher connects the scattered data, and illustrates in a memorable way the value of a principle of classification in helping us to deal intelligently with a multiplicity of facts. He, as it were, takes stock of the progress of his scholars at the end of the first stage of their geographical education, and makes an important forward step in the direction of more advanced teaching.

If I have succeeded in making clear my conception of the plan of education, it will be seen that the same practical method of instruction, so advantageous with regard to the home environment, should be continued when the horizon of vision widens. Already, before the lessons are begun that deal with the geography of the fatherland, allusions and suggestions have been made that have prepared the way for the fuller treatment of that subject, which, therefore, when at last reached, is not by any means unfamiliar. Though actual journeys beyond the limits of the parish or immediately surrounding district may not be possible, much advantage will be found in making imaginary ones, the teacher acting as leader, and guiding the scholars in traverses across the map. In the course of a series of traverses in various directions from the school as a center, a considerable stock of miscellaneous information regarding the surrounding region will eventually be acquired by the pupils. Before they are ready to pass outward to a yet more extensive geographical survey, it will be desirable for them to pursue a similar course to that which they followed before quitting the consideration of the parish. They will be asked to arrange in summary form the information they have gathered, so as to compile a geographical description of another definite area of ground. In the United Kingdom, and generally in English-speaking countries, the next area after the parish for purposes of this kind is the county. And what now remains to be accomplished is to do for the native county what has already been done for the native parish.

The teacher is now in a position to consider the most important step that his scholars have yet taken in their geographical training. They have now to realize the relation borne by their own surroundings to the whole country. As before, this step must be taken deliberately upon a map, which ought to be a large, clearly engraved wall-map of the country, not overloaded with details. The first use of such a general map of the country probably requires a greater mental effort on the part of young learners than we usually suspect. It affords, however, according to the method of instruction here advocated, another and excellent opportunity of training the sense of proportion in geography. The faculty of readily appreciating the relation between the map and the area it represents ; of recognizing the actual value of the distances expressed upon the map ; of realizing from the engraved lines of water-course what must be the general disposition of the ground, should be sedulously cultivated from the very commencement of the employment of general maps of countries.

When the broad features of the country and the meaning of the more frequent geographical terms have been mastered by an attentive examination of the wall-map, there remains only the final step in the elementary stage of tuition, which is to pass outward from the country and realize its position upon the surface of the earth. I have alluded to the way in which the idea of the shape of the earth is to be impressed upon the minds of the learners. It is at the present stage of their training that this can most conveniently be accomplished. They have gradually had their ideas of geographical space extended from their own immediate surroundings, and are now prepared to realize the conception of the size and form of the whole planet. The simpler kinds of proof of the globular shape of the earth will be given, and the lesson will be illustrated from the school globe, which must now be brought into constant use. Having grasped the notion that they are living on a huge ball, the scholars will next be asked to find out upon the globe the position of their own country. Some little time should be spent in comparing the representation of the country there with that shown on the large wall-map already used. The outlines will be found to be still more generalized, and a crowd of details and names that occupied a place on the wall-map can no longer find room on the much smaller delineation of the country upon the globe. The lesson that was enforced in passing from the large parish plan to the county map, and from the county map to the general wall-map of the country, may now again be dwelt upon in advancing from the wall-map to the globe. And thus, by a continuous chain of illustration, the minds of the learners are led upward and outward from their school surroundings to realize the shape and dimensions of the earth.

In bringing to a close my remarks on the elementary stage of geographical teaching, let me allude to one great advantage which the method of instruction here advocated seems to me to possess. In too many cases the education of the young never advances much beyond the elementary stage. If the geography-lessons have consisted of mere pages of definitions and statistics mechanically learned by rote, they are pretty sure to be soon in great part forgotten, and they leave little or no permanent influence behind them. But if such a system as I have sketched be followed, a lasting benefit can not but remain on the minds and characters of the young learners, even though most of the facts that were familiar enough at school should eventually slip out of their memory. Trained to use their eyes, and to reflect upon what they observe, they start in the race of life with those faculties quickened that tell powerfully on success. They are furnished, too, with a source of perennial pleasure in that capacity for the perception and enjoyment of Nature which these early lessons will have fostered.

Fully to discuss advanced geographical education as it deserves would require an ample and exhaustive treatise. This it is no part of my present plan to attempt. What I wish to do is rather to show how the same guiding ideas may be pursued from the elementary into and through the advanced stage. The latter is broadly characterized by the use of class-books or readers, by the practice of written exercises and essays, and by greater precision, detail, and breadth in the manner of treatment. The line to be pursued will largely depend upon the individual predilections of the teacher himself. In some cases the historical, in others the literary, in others the scientific aspect will be most congenial. It is well that insight into each of these sides of geography should be gained by the pupils. But, above all, the instruction must be earnest and thorough. I come back once more to the idea expressed at the beginning of these chapters that, in the higher stages as well as in the lower, the success of the teacher of geography depends upon his own firm grasp of his subject, upon the living interest he takes in it, and upon the sympathy which he can awaken in the minds and hearts of the young.

A KITCHEN COLLEGE.

By H. BROOKE DAVIES.

KITCHEN College! Well, why not? We have a College of Music, of Surgeons, of Physicians, of Preceptors; why not a College of the Kitchen?

It seems a little absurd at first sight, and yet the only absurdity is, that no one ever thought of it before. For many years the servant-grievance has been before the public. The scarcity and inefficiency of domestic servants have been talked about till we are almost as weary of the subject as of our incapable cooks and house-maids, but nothing seems to have been done to remedy the evil; there has been no improvement except in wages, for, no matter how incompetent the servant may be, she demands and gets high wages, and gives very general dissatisfaction.

I do not mean to touch here on the facilities offered of late years by classes and schools of cookery—doubtless servants can learn much from a course of clever practical lectures—but I would venture to point out that in the majority of cases the persons attending the classes are not servants, but ladies—mistresses in many instances—who go with the praiseworthy intention of learning how to be practical cooks by seeing a practiced instructor roll out pastry, or bake fancy bread in a gas-stove, and then go home and attempt to teach their own cooks; the second-hand instruction frequently taking a negative form, such as, "Cook, that's not the way to make puff pastry, that's not the way to make a custard, or truss a chicken"; the mistress herself having only a very indistinct recollection of what *is* the way.

However much good the schools and cooking-classes may have done, they do not seem to have reached the real root of the domestic-servant difficulty; they have caused no perceptible improvement in servants as a class. Servants are still scarce and unsatisfactory, and there is still the same evident distaste for service among the young women of the working-classes from which we naturally expect to draw our supply. Business of any sort, no matter how unhealthy, precarious, fatiguing, and unremunerative, is preferred to domestic service. A girl will work twelve hours a day and half starve rather than become a house-maid or kitchen-maid, with good food, a comfortable home, and comparatively easy work.

Now, there must be a strong reason for this very wide-spread dislike for service. It is not the love of personal liberty and feeling of independence. No working-woman in the world has less liberty, independence, and comfort than the out-of-door business girl in London. She has to serve not one but many masters; her work gives her neither time for pleasure nor means of enjoyment; her life is one long round of toil, the only variation being from seams to button-holes, from button-holes to seams, yet she clings to "business" with the strongest tenacity! Why? In the first place, she thinks it respectable; "business" is such a delightfully vague term! It may mean anything. But "service," there is no mistaking the meaning of that word. "Only a servant" is considered the most contemptuous designation. To an uneducated and untrained girl the rules and regulations of service seem very rigid. Service entails neatness, order, politeness, industry, truth, honesty, morality—in short, all the qualifications that go to form a good woman and a good citizen; and where, we may reasonably ask, are young women to acquire all those good qualities before going to service? Failing in them, they fail to give satisfaction to the employer, and hence the everlasting complaints. Besides considering it a disgrace to be a servant, girls have an idea that in domestic service there is no chance of "getting on," while "business" of any sort is full of possibilities; and a third and prevalent objection is that they lose all opportunity of *bettering* themselves by marriage—their prospects are limited strictly to their own class. Those are the weightiest objections young women have to service, and it must be confessed they are not entirely unfounded. No doubt there has been much done of late years to help servants, both physically and morally, but I am not aware that anything has been attempted from a sociological point of view; their position is in many respects worse than it was a hundred years ago. Then, though a servant was ill-paid and more frequently not paid at all, there were compensations, there existed a certain amount of intimacy between master and man, mistress and maid; there were kindly feeling, interest, confidence on the one side, fidelity on the other, the servant was not unfrequently the counselor, and very generally the companion of the master, and took a keen personal interest in all his affairs. Now there are mistrust and suspicion on both sides; the maid thinks the mistress makes it the pastime of her idle moments to worry and find fault with her, while the mistress believes the maid's chief pleasure in life is to cross and annoy her; both misunderstand each other, and the result is mutual discomfort. Without exactly wishing to recall the days of "Caleb Balderstone," one can not help desiring a better feeling between persons who have to live in such very close contact as mistresses and servants. In no other calling whereby a woman earns her bread is she brought into such strictly personal relations with her employer as in service; under no other circumstances is an employer bound to be so careful in investigating the character of the person employed. Our children, at the most tender and impressionable age, are left almost exclusively to the care of servants; our food, on which so much of the health and happiness of our lives depend, is entirely at their mercy. We intrust them with everything we value most, with no better guarantee of their efficiency than the word or the letter of a complete stranger. In short, we expect a great deal from our servants, and it is reasonable to ask, What do we give in return, what have we ever done for a class on whom we are so dependent, what effort has been made to raise the tone of service, what inducements are offered to respectable young women to enter the ranks? None, or comparatively none! High wages do not prove a sufficient attraction; in no case is the remuneration high enough to secure a competence for old age, without many, many years of toil; there are no fortunes to be made, no special advantages even to be gained, by special skill or integrity. An extravagent, inefficient cook gets as well paid as a capable, economical one, specially among the middle classes, who can not afford to pay for the very best service.

Most people will admit that average servants of late years have deteriorated, partly owing to the fact that they are drawn from an inferior class, and partly because in the terrible march of mind of the last twenty years they have been left behind, their position as a class absolutely ignored; though their failings are ever before us, nothing has been done for their improvement. In one respect the middle classes are unfortunate, they have to suffer for the faults of the upper classes; the kitchen-maid of Belgrave Square becomes very often the cook of a less aristocratic neighborhood, and the waste and extravagance permitted in the kitchen of a rich man are ruinous in the professional man's semi-detached villa, and the cook gets blamed for what, after all, is only the result of improper training. In short, at the present time servants are either badly trained or not trained at all, and therefore we want a Kitchen College.

In other words, we want a thoroughly organized and recognized center, school, college—the name is immaterial—where servants can study and pass such an examination and gain such a certificate as will be a proof of skill and competence not only in one special department, but of general capacity and respectability; that qualifications should be given according to merit; and that the institution should be so managed that a woman would feel as proud of a degree from the "College for Domestic Servants" as from any other college open to women. Cooks, house-maids, parlor-maids, and nurses have all well-defined duties, and a competitive examination is the best method of testing their skill. A nurse frequently knows less about children than any other living creature; she has the haziest ideas about draughts, the most supreme contempt for ventilation, and firmly believes a baby never cries unless it is hungry, and forthwith gives the inevitable bottle, frustrating Nature's efforts to exercise and expand the lungs. A general servant who can cook tolerably and knows a little about housework is the exception; as a rule, she is deplorably ignorant of both. Up to the present a good character has been the only guarantee of efficiency, but it is clear that it is by no means an infallible test; a servant that one mistress may have thought satisfactory may prove quite the reverse to another. But a trained and certificated servant, who knows her work and does it, would be in a position to ignore fault-finding, or, still more satisfactory, not deserve it, she would be less liable to dismissal for imaginary faults, and she would be to a great extent independent of "characters." As it is, the domestic servant is a sort of shuttlecock tossed from one mistress to another, leaving a different impression on the mind of each. In short, the servant has no standing, no ideal of excellence, no ambition ; her life is monotonous and often sordid in its details, her mental and social condition are both uncared for. Surely this ought not to be, and the wives, mothers, and daughters of England should consider it. We live with our servants as if they were aliens, and then wonder they do not serve us with love and gratitude.

It may be objected that training, general education, and the granting of degrees would make a class already difficult to deal with still more so, and that servants would consider themselves the equals of their employers. I think the effect would be just the reverse : a sensible and liberal education would teach women not only what is due to themselves, but what is due to others ; and a feeling of independence that the thorough knowledge of his business gives to every worker in every craft would make servants much less suspicious and less resentful. Honest service without servility, cheerful politeness without undue familiarity, cleanliness, economy, and truth, are what we most desire in our domestics ; and without education and training how can we reasonably hope to get them? It may be argued against this college scheme, that the effort made years ago to induce better-class women to enter servitude under the name of "lady-helps" proved a failure. A little reflection would have shown that it could not have proved anything else. The lady-help was an artificial growth, and could not possibly meet a real want. We do not want ladies to become servants, neither their habits nor instincts fit them for the occupation : pride and prejudice, sensitiveness, and I might add ignorance, are bad foundations ; but it may not be *too Utopian* to hope that servants may become more like ladies, or at least that the ignorant, slipshod, sullen "slavey" who works without hope, and idles without enjoyment, may disappear from among us, and that the time is not far distant when a domestic servant can hear herself spoken of as such, if not with honest pride, at least without shame or discontent.

Therefore, we want a Kitchen College for women, not a school of cookery or conglomeration of unorganized "classes," but a school of everything a servant ought to know ; a school or college with exhibitions and scholarships and diplomas, with clever lecturers, and clear, simple text-books, and fees that will come within the means of women who have to work for their daily bread.

The starting and conducting of such a college ought to be woman's work ; women suffer most from the ministrations of inefficient servants, women benefit most by the attention of good ones; and I have no doubt that there are in England women enough—generous, warm-hearted, thoughtful women—to found such an institution; women enough, from the very highest lady in the land, down to the poorest mother of a family, waited on by a nameless little maid-of-all-work from St. Luke's, to stretch out a helping hand to their sisters in service, and give them what every woman has a right to, the means of improving their social standing.

One word more: Kitchen College must be no charity. To make it a success, it must be as much a national institution as the University of Oxford; its degrees, certificates, and prizes must be worked for, fought for, and won, by the most deserving, not as an "imperfect favor, but a perfect right."—*Nineteenth Century.*

WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

II.

UNDER geographical variation many interesting facts have been added since Professor Baird, Dr. Allen, and Mr. Ridgway published their capital discoveries calling attention to the variations observed in birds and mammals coincident with their latitudinal range. William Bartram, grand-nephew of the famous botanist John Bartram, alludes to the effect of climate in modifying species. In speaking of birds he says, "The different soil and situation of the country may have contributed in some measure in forming and establishing the difference in size and qualities betwixt them."

Dr. J. A. Allen † shows marked geographical variation among North American mammals in respect to size. He shows that—"1. The maximum physical development of the individual is attained when the conditions of environment are most favorable to the life of the species. 2. The largest species of a group (genus, sub-family, or family, as the case may be) are found when the group to which they severally belong reaches its highest development, or when it has what may be termed its center of distribution. 3. The most typical or most generalized representatives of a group are found also near the center of distribution, outlying forms being generally more or less aberrant or specialized." In the study of the eggs of birds of the same species, North and South, Dr. Allen shows that in the South the

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

† "Bulletin of the United States Geological Survey of the Territories."

eggs are less in number and smaller in size.* Mr. Robert Ridgway † calls attention to the geographical variation observed in *Dendrœca*.

The same author,‡ in a discussion of a paper by Salvin in the "Transactions of the Zoölogical Society of London," on the relationships between the birds of Guadeloupe and the mainland, refers to the present genesis of species, and points to the increase in size of the bill and feet, the shorter tail and wings and darker colors, as characterizing them.

Dr. E. C. Coues,# in his studies regarding geographical variation in color among North American insectivorous mammals, says: "My studies up to the present go to show a very interesting parallelism with the state of the case I have determined for other small mammals, notably the mice and gophers, and which my friend Mr. Allen has admirably brought out in his studies of the squirrels. In some cases I find almost identical effects of climatic or other conditions upon the shrews and the mice of particular localities, by which they both acquire the same *facies loci*. Present indications are that the normal variability of the shrews in size, shape, and color is not less than has been determined to hold good in various other families of mammals." In this memoir Dr. Coues has verified a curious fact, first pointed out by Professor Baird, of the modifications of the premolar dentition which the Western species collectively, as compared with the Eastern, have undergone: "A striking peculiarity of all the Western species, no matter how diverse in other respects, is to have the 'third premolar' decidedly smaller than the 'fourth,' while in all the species east of the Rocky Mountains (with one possible exception) the same tooth is as large as, or larger than, the other. Of the fact there is no question; it may be observed in an instant, and is unmistakable. Its significance is another thing. Some of the Western species are scarcely distinguishable if at all from their respective Eastern analogues, except by this character, and they all show it."

Professor A. Hyatt ‖ finds in sponges geographical variation in color, referring to similar features in birds as recorded by Baird and others.

Professor David S. Jordan,^ in a paper on the distribution of fresh-water fishes, presents a concise series of propositions which govern these animals in the United States. They all point to the action and importance of physical conditions as governing distribution. Space will permit only the quoting of the last proposition, which is a summing up of his conclusions: "The distribution of fresh-water fishes

* "Bulletin of the Nuttall Ornithological Club," vol. i, p. 74. † Ibid., p. 81.

‡ Ibid., vol. ii, p. 58.

\# "Bulletin of the United States Geological Survey of the Territories," vol. iii, No. 3, p. 635.

‖ "Memoirs of the British Society of Natural History," vol. ii, part iv.

^ "American Naturalist," vol. xi, p. 607.

is dependent on (*a*) fresh-water communication; on (*b*) character of stream, that is, of water, as to purity, depth, rapidity, vegetable growth, etc.; on (*c*) the character of the river-bed, as to size, condition of bottom, etc.; on (*d*) climate, as determined by latitude and by elevation above the sea; and, finally, on (*e*) various unknown factors arising from the nature or the past history of the species in question, or from the geological history of the rivers."

Dr. James Lewis * has observed a not unlike condition of things in the distribution of the fresh-water mussels of Ohio and Alabama. By a series of tables he calls attention to what he believes is the occurrence of identical and equivalent species in the two systems of drainage, and suggests that, owing to the number of varieties characterizing the *Unionidæ* they may be identical. This author † has also studied the genus *Io* and its habits, and notices its variation coincident with latitude and temperature.

Dr. R. E. C. Stearns,‡ in a paper on the circumpolar distribution of certain fresh-water mussels and the identity of certain species, unites many hitherto recognized species of *Anodonta*. Dr. J. G. Cooper,# in a study of the fossil and sub-fossil land-shells of the United States, sees the strongest evidence in support of the idea that the older ones are the direct ancestors of certain forms living to-day.

Mr. R. P. Whitfield ‖ read a paper before the Boston Society of Natural History, showing changes produced in *Limnæa megasoma* when kept in an aquarium. Having at the outset three specimens, two of them finally died, and from the remaining one eggs were produced, presumably unimpregnated. These eggs hatched, and from these the next year came a second generation, which in turn produced a third generation the following year. The animal of *Limnæa* is hermaphrodite. Nevertheless, besides diminished size in the shell, it was observed that the male parts had disappeared, and the liver had become considerably reduced in size. He shows that a diœcious species had in a short time become monœcious as a result of the new physical conditions of life in the constricted quarters of an aquarium.

An instructive paper by D. W. D. Hartman,^ on the genus *Partula* of the Hawaiian Islands, shows in the most convincing manner the effect of environment in modifying the species. He finds a common occurrence of hybrids among certain forms, the result of the union of proximate species. This hybridization occurring even between arboreal and ground species, Dr. Hartman states that "gravid females are often washed by heavy rains from a favored position to drier levels, where after a few generations the progeny become depauper-

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1877, p. 26.

† "American Naturalist," vol. x, p. 321.

‡ "Proceedings of the California Academy of Natural Sciences."

\# Ibid., vol. i, No. 4, p. 235.

‖ "American Naturalist," vol. xiv, p. 51. ^ Ibid., vol. xvi, p. 581.

ated, and so stunted in size as to be mistaken for distinct species." Dr. W. H. Dall,* in some general considerations regarding the environment of the deep-sea mollusks, as compared with the shallow-water and littoral forms, shows how much the littoral forms have to contend with in the struggle for existence as compared with the deep-sea forms, and the delicate sculpture and extreme fragility of many of the shells occurring in the deeper abysses of the sea are to be explained on the ground of their habitat. Dr. Carl F. Gissler † has presented some interesting evidences of the effect of chemico-physical influences in the evolution of the branchiopod crustaceans.

The effect of mechanical strains as producing like morphological effects has been treated in a masterly way by Dr. John A. Ryder.‡ He cites the vertebral axes of turtles and extinct armadillos, also the sacra of birds and mammals, and says: "These observed coincidences, it is believed, are neither accidental, nor designed by an active cause external to these organisms or their cosmic environment. I would rather believe that the structures, so far as they have been evolved in parallel or similar ways, are the results of like forces conditioning growth and nutrition in definite modes and determinate directions. The manner of incidence of the modifying forces being in all cases determined by the voluntary actions of the organisms, the actions in turn are determined by the degree of intelligence of the animal manifesting them."

In considering the "Laws of Digital Reduction,"# Dr. Ryder gives a concise presentation of the various groups of animals, showing in each the line of mechanical strain in the extremities and its correlation with the increased development of those digits bearing this strain, and the consequent reduction or atrophy of those digits out of this line. These considerations led him to the following conclusions:

"1. That the mechanical force used in locomotion during the struggle for existence has determined the digits which are now performing the pedal function in such groups as have undergone digital reduction.

"2. That where the distribution of mechanical strains has been alike upon all the digits of the manus or pes, or both, they have remained in a state of approximate uniformity of development.

"3. It is held that these views are Lamarckian and not Darwinian—that is, that they more especially take cognizance of mechanical force as a mutating factor in evolution, in accordance with the doctrine of the correlation of forces."

Dr. Ryder further says, "It seems a most convincing proof of the doctrine of descent to find man an instance of the same kind of

* "Bulletin of the Museum of Comparative Zoölogy," vol. xii, No. 6, p. 183.

† "Proceedings of the American Associated Antiquarian Society," vol. xxix, p. 557.

‡ "American Naturalist," vol. xii, p. 157.

\# Ibid., vol. xi, p. 603.

specialization determined by the manner of the distribution of strains as is so often found among the lower groups, such as the horses, sloths, jumping-mice, and even-toed ungulates."

In another memoir* Dr. Ryder considers the mechanical motion in forming and modifying teeth. Considering first the simplest form of movement in the mammal's jaw, opening and closing, without fore and aft or lateral movement, he shows the successive changes going on coincident with the more complex movements of the jaw, and that the enamel foldings, ridges, crests, etc., have apparently been modified in conformity with the ways in which the force used in mastication was exerted.

Professor A. Hyatt,† in an exhaustive study of the Planorbis of Steinheim, shows among other things the effect of gravitation as accounting for the form of the mollusk-shell, citing examples from all the classes, and even drawing examples from other subkingdoms to support his views.

Professor E. D. Cope,‡ in a memoir on "Archæsthetism," considers the hypothesis of use and effort, the office of consciousness, etc. He attempts to show that consciousness is primitive and a cause of evolution. He sustains his thesis by a series of arguments which, if not beyond my grasp, would be too extensive to present here. I can only repeat the regret I expressed in the Buffalo address, namely, that neither Professor Cope nor Professor Hyatt has yet been induced to present to the public an illustrated and simple outline of their theories. Such a demonstration, I am sure, would be acceptable not only to the public but to many scientific students as well. While these two eminent naturalists believe fully in the derivative theory, they insist that Darwin's theory is inadequate to explain many of the phenomena and facts which they encounter in their studies. Darwin has distinctly said in his first edition of the "Origin of Species," "I am convinced that natural selection has been the main but not the exclusive means of modification"; and in his sixth edition of the same work, in quoting these words, he laments that he is still misunderstood on this point. The theory of acceleration and retardation of these authors is, if I understand it rightly, a very plain case of natural selection. It was inevitable that those individuals that matured the quickest were better prepared to defend themselves, were quicker in the field, were able to give their offspring an earlier start in the season, were in every way more fitted to survive than those which matured later. It is assumed that this is a law, when, to my mind, it seems the simplest result of natural selection. Instead of overriding it, it is only a conspicuous result and proof of it.

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1878, p. 45.

† "American Naturalist," vol. xvi, p. 441. Also "Proceedings of the American Associated Antiquarian Society," vol. xxix, p. 527.

‡ "American Naturalist," vol. xvi, p. 454.

A parallel case may be seen in the increase in size of the brain in the vertebrates, and conspicuously in the higher vertebrates, since their first appearance in geological history. The individual brain clearly varies in size, and it does not require a great effort to perceive how in the long run the greater brain survives in the complex struggle for existence. Associated with the greater development, parts that were freely used for locomotion before are now compelled to perform additional service, and through the law of use and effort, which all admit as an important factor, organs are modified in structure, the anterior portion of the body assumes a new aspect; and it was on the character of these parts and aspects that Professor Dana was led to formulate his comprehensive and ingenious principle of cephalization. It is a result and not a cause. And so I believe, though with great deference to Cope and Hyatt, that the laws of acceleration and retardation, exact parallelisms, inexact parallelisms, and still more inexact parallelisms, and many other laws and theories advanced by these gentlemen, are not causes but effects, to be explained by the doctrine of natural selection and survival of the fittest.

The connecting links and intermediate forms which the skeptical public so hungrily demand are continually being discovered. Great gaps are being closed up rapidly; but the records of this work, being published in the journals of our scientific societies, are hidden from the public eye as much as if they had been published in Coptic. So rapidly have these missing links been established that the general zoölogist finds it difficult to keep up with the progress made in this direction. He can hardly realize the completion of so many branches of the genealogical tree.

Professor Cope,* who has accomplished so much in this direction, says: "Those who have, during the last ten years, devoted themselves to this study, have been rewarded by the discovery of the course of development of many lines of animals, so that it is now possible to show the kind of changes in structure which have resulted in the species of animals with which we are familiar as living on the surface of the earth at the present time. Not that this continent has given us the parentage of all forms of animal life, or all forms of animals with skeletons, or vertebræ, but it has given us many of them. To take the vertebrata, we have obtained the long-since extinct ancestor of the very lowest vertebrates. Then we have discovered the ancestor of the true fishes. We have the ancestor of all the reptiles, of the birds, and of the mammals. If we consider the mammals, or milk-givers, separately, we have traced up a great many lines to their points of departure from very primitive things. Thus we have obtained the genealogical trees of the deer, the camels, the musk, the horse, the tapir, and the rhinoceros, of the cats and dogs, of the lemurs and monkeys, and have important evidence as to the origin of man."

* "Popular Science Monthly," vol. xxvii, p. 605.

In 1874 he predicted that the ancestor of all the mammals would be a five-toed, flat-footed walker, with tubecular molar teeth, or in exact language, a pentadactyl, plantigrade bunodont. Seven years after, he obtained evidences that such a type of mammals abounded in North America during the early Eocene Tertiary period. Professor Cope,* in his phylogeny of the camels, shows a remarkable parallel to that of the horse, both forms appearing in the Lower Eocene. Mr. Eugene N. S. Ringueberg† believes he has found in a thin layer of limestone at Gasport, New York, a deposit in which a number of forms of brachiopods seem to present the intermediate stages between certain brachiopods common to the Clinton and the group of rocks immediately above. While the majority of species in this deposit belong to the Niagara, there are among the fossils met with three species of brachiopods which were supposed to have passed out of existence with the Clinton. He finds in this bed thirty-two forms peculiar to the Niagara, eleven common to Niagara and Clinton, three belonging to the Clinton, and two characteristic forms of the transition group. Many of these show intermediate characters.

Professor H. S. Williams,‡ in his paleontological studies of the life-history of *Spirifer lævis*, in which he traces the ancestral line of this creature, says: "Whatever theoretical description we may give to species, here are, in the first place, an abundance of individual organisms whose remains are found in the Upper Silurian rocks of Europe, Great Britain, and America, presenting a few clearly marked, distinctive characters, which are found variously developed in the individual forms, but so grading in the various varieties as to cause careful naturalists to associate them as varieties of a single species."

Dr. C. A. White,# in his comparisons of the fresh-water mussels and associated mollusks of the Mesozoic and Cenozoic periods with living species, expresses his belief that the present *Unios* of North America, particularly those forms allied to *Unio clavus*, have come down in an unbroken line from the Jurassic and possibly from earlier times. He shows that thus far all the fossil *Unios* have been obtained from lacustrine deposits, none of these beds being distinctly fluviatile. He furthermore calls attention to the fact that "these lacustrine formations are of very great extent in Western North America, and, without doubt, the lakes in which they were deposited were caused by encircling bands of rising land during the elevation of the continent. These great landlocked waters were at first brackish, but finally became, and for a long time remained, fresh, continuing so until their final desiccation." From this commingling of salt and fresh water he justly assumes that many modifications arose in the forms of *Unios*

* "American Naturalist," vol. xx, p. 611. † Ibid., vol. xvi, p. 711.

‡ "American Journal of Science and Arts," vol. xx, p. 456.

\# "Bulletin of the United States Geological Survey of the Territories," vol. iii, No. 3.

subjected to these influences, and hence has resulted a variety of forms which have gone on continually widening to the present day.

Professor A. G. Wetherby,* in a paper on the geographical distribution of certain fresh-water mollusca and the possible cause of their variation, shows the paucity of forms of *Unionidæ* on the Pacific and Atlantic coasts as compared to the richness and profusion of those forms in the central portion of the continents. He remarks also on the absence of the family *Strepotomidæ*, east of the Alleghanies. He assumes that the first fresh-water forms were lacustrine. He points out the well-known geological fact of large inland inclosures and their subsequent drainage, and shows the vicissitudes which must have been encountered by species in the variety of physical conditions implied by these changes. In this connection I may be permitted to call attention to the fact that at a meeting of this Association, at Hartford, in 1874, I made a communication on the origin of the North American *Unionidæ*, in which I urged some of the points made by Dr. White and Professor Wetherby.†

Dr. Thomas H. Streets,‡ in studying the immature plumage of the North American shrikes, was much struck with the close resemblance between the plumage of the young of *Sula cyanops* and the adult plumage of another species. Recalling a generalization made by Darwin, that "when the young differs in color from the adult, and the colors of the former are not, as far as we can see, of any special service, they may generally be attributed, like various embryological structures, to the retention by the young of the characters of an early progenitor." He then shows the gradation between the several species of shrikes from this standpoint, and traces their descent from a common ancestor.

* "Journal of the Cincinnati Society of Natural History," vol. iii, p. 357, and vol. iv, p. 156.

† The following is a brief abstract which was published in the Hartford "Courant," August, 1874: "Mr. Morse, in explaining the origin of the North American *Unionidæ*, did not pretend to point out the absolute line of descent in these forms, but wished to call attention to some curious features in the possible derivation of the fresh-water families of mollusks from cognate genera living in salt water. It is observed, first, that the few families of fresh-water mollusks are intimately related to those forms which live in the sea between high and low water mark, and those which can withstand the influence of brackish water. He cited certain families of fresh-water mollusks which are so closely related to tidal forms as hardly to be distinguished from them. . . . In explaining the immense number of species of fresh-water mussels in America compared to the very few forms in Europe, we might look to an explanation of this feature in the past geological history of the two continents.

"In Europe there have been no great inland seas, while in America its past history shows the inclosing of large tracts of water in which freshening from brackish water went on, and, while many forms succumbed to these changed conditions, only those forms survived which resemble certain littoral species. And with the curious modifications that must have taken place in these changed conditions, one gets a possible explanation of the great variety of mollusks in our Western rivers."

‡ "American Naturalist," vol. xvii, p. 389.

Professor S. A. Forbes,* in a study of the "Blind Cave Fish and their Allies," is led to review the conclusions reached by Professor F. W. Putnam in his interesting papers on the subject. Professor Putnam brought forth a number of arguments which seemed to him to militate against the views urged by evolutionists that their peculiar characters were adaptive and the result of their cave-life. He was led to the conclusion that the absence of light had not brought about the atrophy of the eyes, the development of special sense-organs, and the bleaching of the skin. In referring to another cave-fish, Chologaster, with eyes fully developed, it was urged that the argument in regard to eyeless fishes could have no weight. In response to this it was answered that possibly Chologaster had not been subjected to subterranean influences long enough to be affected, and this objection was anticipated by urging that we have no right to assume that Chologaster is a more recent inhabitant of the caves, until proved.

The discovery of another species of Chologaster, taken from a spring at the base of a limestone cliff in Illinois, has given Professor Forbes an opportunity to make careful comparisons with the cave Chologaster. He says in regard to it, "The most important and interesting peculiarity of this species indicates a more advanced stage of adaptation to a subterranean life than that of its congeners." Referring to Professor Putnam's arguments, Professor Forbes says that "the discovery of a species of Chologaster, which frequents external waters, of an immediate subterranean origin, supplies all needed proof that the genus either has a shorter subterranean history than Amblyopsis, or, at any rate, has remained less closely confined to subterranean situations; and that in either case the occurrence of eyes, partial absence of sensory papillæ and persistence in color, are thus accounted for consistently with the doctrine of 'descent with modification.'" In this connection it may be of interest to read the curious fact recorded by Mr. S. H. Trowbridge,† of the discovery in the Missouri River of a shovel-nosed sturgeon which had the skin growing over the eyes, completely inclosing them. Dr. S. H. Scudder,‡ in a memoir read before the National Academy, brings forward evidence to show that ordinal features among insects were not differentiated in Palæozoic times, but that "all Palæozoic insects belonged to a single order which, enlarging its scope as outlined by Goldenberg, we may call Palæo-dictyoptera; in other words, the palæozoic insect was a generalized hexapod, or more particularly a generalized Heterometabolon." In a memoir on the earliest winged insects of America, embracing a reexamination of "The Devonian Insects of New Brunswick," published by the author, Dr. Scudder replies to some sharp criticisms and objections made by Dr. Hagen, and pertinently says, that "there is no evidence—but the contrary—that Dr. Hagen in his investigations

* "American Naturalist," vol. xvi, p. 1. † "Science," vol. iii, p. 587.

‡ "American Naturalist," vol. xix, p. 877.

uses the 'theory of descent' as a working hypothesis, without which no one studying any group of animals in the period of its rise and most rapid evolution can expect to do otherwise than stumble and wander astray. To refuse it is to merit failure."

Professor J. S. Kingsley, in his study of Limulus, regards it as an Arachnid, but states that its ancestors take us back to a time when the distinctions between the Crustacea and Arachnida were far less marked than now.

Dr. A. S. Packard,* in a paper on the "Genealogy of the Insects," shows by means of a "genealogical tree" the descent of the class from the Thysanura, with some hypothetical creature not unlike Scolopendrella, as the probable stem-form of the hexapods. It is through the resemblance the larvæ of the different orders of insects bear to various members of the Thysanura that this scheme is justified. It may not be out of place to say here that the use of the "genealogical tree," in suggesting the probable line of descent of various allied groups, has been severely condemned by some as leading to no practical good in classification. It seems to me, however, the only clear scheme for the proper working out of the ascertained or hypothetical relationships of animals ; it is thought-exciting, its very attitude provokes studious inquiry and suggestive inferences. It may be called the modern tree of knowledge.

The modern genealogical tree as used by the biological student (and as well by the ethnologist, philologist, and others) is a graphic diagram of the relationships between groups as understood by the projector, and, as such, is a most commendable and useful method with which to illustrate his meaning. With additional knowledge one can see at a glance the points that need strengthening, and he can pare, prune, or even graft new fruits on the old stock, or, if it is rotten at the trunk, cut it down altogether. These trees have always been in vogue with the older naturalists, only, in the old style of arboriculture, the trunk was always kept stiffly vertical, while the branches were bent down and trained horizontally, being flimsily attached to the main stem by printers' devices of long and short brackets. In this attitude it reminded one of the dwarfed and deformed trees of the Chinese, and very properly typified the dwarfed and deformed way of looking at classification.

Never was the provisional use of a genealogical tree more completely justified than in a memoir by Dr. Alexander Agassiz † on the "Connection between Cretaceous and Echinid Faunæ." He certainly speaks in no uncertain terms when, in considering the Spatangoids of the chalk, he says, "They lead us directly through the *Palæostominæ* and the *Collyritidæ* to the *Ananchytidæ* which have persisted to the present day," and other relationships of the same nature are repeated-

* "American Naturalist," vol. xvii, p. 932.

† "American Journal of Science and Arts," vol. xxiii, p. 40.

ly urged as would not only justify the use of the genealogical diagram against which he so strongly inveighed in his admirable address before this Association at the Boston meeting; but had he adopted this method, a much clearer view of the very points he wished to emphasize would have been afforded his readers.

It was the strictures of Agassiz above referred to that led Professor W. K. Brooks* to write a paper on the subject of "Speculative Zoölogy," in which he most earnestly and ably defends the use of genealogical diagrams, and justly says: "If phylogenetic speculations retard science, speculations upon homology must do the same thing; and the only way to avoid danger will be to stick to facts, and, stripping our science of all that renders it worthy of thinking men, to become mere observing machines."

Since 1876 Professor Marsh and Professor Cope have in various journals and Government publications presented the results of their discoveries of the past vertebrate life of North America. The General Government has published the two great monographs of Professor Marsh on the Dinocerata, an extinct order of gigantic mammals, and the Odontornithes, an order of extinct toothed birds, as well as Professor Cope's great volume on the Tertiary Vertebrata, besides other memoirs by the same authors. Space will forbid more than a passing allusion to the varied and remarkable additions to our knowledge of extinct vertebrate life made by these naturalists.

Had a moiety of the work accomplished by these investigators been known to Geoffroy Saint-Hilaire, the theory of descent would have been established long before Darwin, though to Darwin and Wallace belongs the full credit of defining the true cause. Leidy, Marsh, and Cope have not only brought to light a great number of curious beasts, many of them of gigantic and unique proportions, but forms revealing in their structure the solution of many morphological puzzles, and throwing light on the derivation of many obscure parts.

The discovery in the Western tertiaries of multitudes of huge and monstrous mammals and, earlier still, of gigantic and equally monstrous reptiles, naturally led at once to an inquiry as to the cause of their extinction. "Nothing can be more astonishing," says Professor Joseph Le Conte,† "than the abundance, variety, and prodigious size of reptiles in America up to the very close of the Cretaceous, and the complete absence of all the grander and more characteristic forms in the lowest Tertiary; unless, indeed, it be the correlative fact of the complete absence of mammals in the Cretaceous, and their appearance in great numbers and variety in the lowest Tertiary. . . . The wave of reptilian evolution had just risen to its crest, and perhaps was ready to break, when it was met and overwhelmed by the rising wave of mammalian evolution." In this paper of Le Conte's, which is entitled

* "Popular Science Monthly," vol. xxii, pp. 195, 364.

† "American Journal of Science and Arts," vol. xiv, p. 99.

"On Critical Periods in the History of the Earth and their Relation to Evolution: and on the Quaternary as such a Period," may be found an excellent rejoinder of Professor Clarence King's lecture before the Sheffield Scientific School on the subject of "Catastrophism and Evolution."

Among the most interesting discoveries connected with these creatures is the determination by Professor Marsh * that these early mammals, birds, and reptiles had brains of diminutive proportions. He says in regard to the order Dinocerata, a group of gigantic mammals whose remains have been found in the tertiary deposits of the Rocky Mountain region, that they are the most remarkable of the many remarkable forms brought to light. The brain of these creatures was remarkable for its diminutive proportion. So small, indeed, was the brain of *Dinoceras mirabile*, that it could "apparently have been drawn through the neural canal of all the presacral vertebræ." In alluding to the successive disappearance of the large brutes, the cause is not difficult to find: "The small brain, highly specialized characters, and huge bulk, render them incapable of adapting themselves to new conditions, and a change of surroundings brought extinction. The existing proboscidians must soon disappear, for similar reasons. Smaller mammals, with larger brains, and more plastic structure, readily adapt themselves to their environment, and survive, or even send off new and vigorous lines. The Dinocerata, with their very diminutive brain, fixed characters, and massive frames, flourished as long as the conditions were especially favorable; but, with the first geological change, they perished, and left no descendants." Professor Marsh says that the brain of Dinoceras was in fact the most reptilian brain in any known mammal.

Professor Cope,† in describing the brain of Coryphodon from the deposits of New Mexico, says: "The large size of the middle brain and olfactory lobes gives the brain as much the appearance of that of a lizard as of a mammal." This is one of the lowest mammalian brains known. There are others from the Lower Eocene with equally low brains as Arctocyon of Gervais and Uintatherium of Marsh. Cope believes that the type of brain of these early creatures is so distinct as to necessitate the erection of a third sub-class of equal rank with the groups Gyrencephala and Lyencephala, which he would define as the Protencephala. He shows their approximation to reptiles.

Cope ‡ refers to Gratiolet as showing that a great development of the olfactory is a character of an inferior type; in fact, the more we ascend into paleontological antiquity, the more we find that the olfactory lobes display a greater development in comparison with the cerebral hemispheres. Dr. B. G. Wilder # has shown that in the lamprey

* "American Journal of Science and Arts," vol. xxix, p. 173.

† "American Naturalist," vol. xv, p. 312. ‡ "National Academy of Sciences," 1876.

\# "American Journal of Science and Arts."

the only part which can be regarded as a cerebral hemisphere lies lateral of the olfactory lobe. In Dipnoi he finds that the cerebral outgrowth is ventrad. In another paper* he says: "In either of these directions in which what may be regarded as the special organ of the mind is projected among these low or generalized forms, there would seem to be mechanical obstacles to any considerable expansion; but dorsally there is opportunity for comparatively unlimited extension, and it is in this direction that the hemispheres begin to develop in the Amphibia and attain such enormous growth in birds and mammals." How far the small brain and presumably stolid intellects brought about the extinction of the huge tertiary mammals may be better understood by the suggestions offered by Professor A. E. Verrill † in a lecture at Yale College, entitled "Facts Illustrative of the Darwinian Theory." He shows what an important factor parental instinct is in the evolution of species. He regards the lack of parental care "as one of the probable causes, though usually overlooked, of the extinction of many of the large and powerful reptiles of the Mesozoic age and of the large mammals of the Tertiary." He says: "The very small size of the brain and its low organization in these early animals are now well known, and we are justified in believing that their intelligence or sagacity was correspondingly low. They were doubtless stupid and sluggish in their habits, but probably had great powers of active and passive resistance against correspondingly stupid carnivorous species. But unless the helpless young were protected by their parents, they would quickly have been destroyed; and such species might, in this way, have been rapidly exterminated whenever they came in contact with new forms of carnivorous animals, having the instinct to destroy the new-born young of mammals, and the eggs and young of oviparous reptiles. Thus it would have come about that the more intelligent forms, by the development of the parental instinct for the active protection of their young against their enemies, would have survived longest, and therefore would have transmitted this instinct, with other correlated cerebral developments, to their descendants."

Professor John Fiske, in his "Cosmic Philosophy," arrived at a similar conclusion in regard to early man. He showed that, when variations in intelligence became more important than variations in physical structure, then they were seized upon, to the relative exclusion of the latter.

The derivative theory has not only clearly revealed the fact that animals have been derived from pre-existing forms, but it shows even more clearly that organs have been evolved as well. It is difficult, in a general review of this nature, to separate clearly the two classes of facts.

Professor Cope ‡ has traced the genesis of the quadritubercular

* "American Naturalist," vol. xxi, p. 516. † "Science," vol. i, p. 303.

‡ "American Naturalist," vol. xvii, p. 407.

tooth in the mammals of the present day. He finds that the type of the superior molar tooth of the mammals of the Puerco epoch was triangular or tritubercular—that is, with two external and one internal tubercle. Of forty-one species of mammals of this epoch all but four of them had this type of tooth. He finds that this tooth exists to-day only in the insectivorous and carnivorous marsupials. In brief, he shows a gradual change taking place from the early primitive type of tooth in the gradual development of another tubercle. The same author,* in defining the characters of an ancient order of mammals, the Amblypoda, says they are the most generalized order of hoofed mammals, being intermediate in the structure of their limbs and feet between the Proboscidia, the Perissodactyla, and Artiodactyla, which fact, together with the small size of the brain, places them in antecedent relation to the latter, in a systematic sense, connecting them with the lower mammals with small and smooth brains still in existence; and in a phylogenetic sense, since they precede the other orders in time, they stand in the relation of ancestors.

Professor Cope,† in a paper read before this Association on the "Classification of the Ungulata," gives special attention to the arrangement and character of the carpal and tarsal bones. He shows that "the weaker structure of the carpus and tarsus appears first in time; that the stronger structure appeared first in the posterior limbs, and that the interlocking structure has greatly multiplied, while the linear has dwindled and mostly disappeared. Here is a direct connection between mechanical excellence and survival."

In the light of Mr. Caldwell's unquestionable determination of the oviparous character of that curious mammal, the duck-bill mole, associated with its known reptilian bearings as deduced from its skeleton and other features, the deductions of Professor Cope‡ regarding the "Relations between the Theromorphus Reptiles and the Monotreme Mammalia" are of great interest.

In the Theromorpha are two divisions, one of which, the Pelycosauria, is limited to the Permian, and of one of this group he makes the following comparisons: "1. The relations and number of the bones of the posterior foot are those of the Mammalia much more than those of the Reptilia. 2. The relations of the astragalus and calcaneum to each other are as in the Monotreme *Platypus anatinus*. 3. The articulation of the fibula with both calcaneum and astragalus is as in the Monotreme order of mammals." In brief, he shows the affinity of this reptile to be with the monotremes, and that the affinities are very important in the light of Mr. Caldwell's researches, and the further fact that the development of the egg is meroblastic confirms, so to speak, the reptilian affinities of the monotremes.

* Wheeler's "United States Geographical Survey," vol. iv, part ii, p. 182.

† "Proceedings of the American Associated Antiquarian Society," vol. xxxi, p. 477.

‡ Ibid., vol. xxxiii, p. 471.

Here, then, are a series of observations by different observers from different standpoints, all telling the same story. Osteologists have long ago pointed out the reptilian affinities of the monotremes from the character of the skeleton. The anatomists in like manner have insisted upon certain reptilian characters as well as avian characters from its internal structure. A trained zoölogist now studies it on the ground, and finds it laying true eggs, a fact that had been insisted upon several times in the present century. More significant still, the study of these eggs shows that they go through a reptilian mode of development. And now the paleontologist brings to light the remains of a reptile from the Permian rocks, and again establishes the same relations.

In this connection the examination by Dr. Henry C. Chapman* of a fetal kangaroo and its membranes is of interest. The fœtus he examined was fourteen days old. He states that it had no true placenta, and says, "If the parts in question have been truthfully described and correctly interpreted, as partly bridging over the gap between the placental and non-placental vertebrates, they supply exactly what the theory of evolution demands, and furnish, therefore, one more proof of the truth of that doctrine."

THE UNHEALTHFULNESS OF BASEMENTS.†

By W. O. STILLMAN, M. D.

IN many American cities basement-houses are quite the rule; and rooms, partly or almost completely below the street-level, are in common use as work and dining rooms, and occasionally for living and sleeping purposes.

A rather casual examination of the standard works, on hygiene, of Parkes, Buck, Wilson, and others, fails to reveal any condemnation of basements, though the dangers arising from damp cellars and foundations are freely discussed. A not unnatural conclusion might be that these eminent sanitarians lived in an air of such hygienic innocence and purity that the possibility of the enormity of basement-living had not occurred to them to be reprehended.

The value of ground-space in modern cities has caused architects to plan for the occupancy of perpendicular space below as well as above the surface of the earth. In very few dwellings are the inhabitants protected from earth-damp, whether a basement or cellar intervenes. Every physician recognizes the dangers arising from damp and cold, not to specify from noxious exhalations, and unhealthy subterranean air-currents. Rheumatism, consumption, malaria, neuralgia, etc.,

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1881, p. 468.

† From a paper read before the Albany County Medical Society, March 23, 1887.

are constantly produced by such conditions. Humanitarians and philanthropists have painted the pitiable horrors of poor wretches living in cellars and dungeons. Are not many of the modern basements practically just as objectionable and injurious as the former?

Modern basements are, first, usually damp. In a clay soil, water is frequently found standing beneath the floor. There is commonly little air-space, the floor being usually laid almost upon the ground. The ground beneath the floor is almost always moist, as far as I have observed in this locality, and this is due to the following facts: 1. It being lower than the street it receives some surface drainage; 2. It often dips far enough down to encounter subsoil saturation, or subterranean streams; 3. Because it is usually improperly drained, if drained at all; and, 4. It is often subject to the leakage of broken or defective drains, cess-pools, etc.

The modern basement is, secondly, in danger of such air contamination as would naturally occur from unimpeded communication, through porous soil, with defective drains, sewer-leaks, and the general subsoil filthiness of a city.

To guard against the undesirable conditions mentioned several things are necessary, and should doubtless be considered in building all basement-houses. First, area-ways, or air-spaces, should be constructed around the outside walls to guard against lateral dampness, and carry off the surface-drainage, which has a tendency to sink down by the outside walls to the foundations. Second, air-spaces should be allowed under basement-floors, and these should be ventilated. Third, damp-proof courses should be laid in all foundation-walls, to prevent the upward spread of moisture throughout the house. An ordinary brick will hold nearly a pint of water. A house not thus protected will always remain damp and unhealthy. Fourth, the entire surface of the ground under a basement-floor should be covered with a layer of concrete, at least six inches thick, and this in turn covered and hermetically sealed, from wall to wall, with a coating of coal-tar or Portland cement. This keeps out vermin as well as damp, and effectually shuts out dangers from leaking sewers or drains. Fifth, the foundations of a house, in a moist soil especially, should be drained. Sixth, the main soil or drainage pipes, which are frequently laid beneath city houses, should not be constructed of tile, brick, etc. With numerous joints, leaks and settlings are apt to occur. Heavy cast-iron pipes are best, as demonstrated by most recent experience.

The above precautions, if not defective, guard a basement against dampness, and also against foul air, coal-gas, effluvia from privy-wells and cess-pools, sewer-gas, and the various exhalations of a not infrequently filth-sodden soil, and it should not be forgotten that an unhealthy basement usually means an unhealthy house. Polluted air is sucked all over the house by the rise of heated air from the basement.

If we must have basements to live in, such safeguards should be enforced. But, for one, I wish to record my protest against our modern living-cellar. A well-ventilated basement is almost an impossibility from its low level, and it is so difficult to get our ideal conditions perfectly executed, that practically they are seldom met with. I have seen a great many cases of sickness which seemed to me due to basement-living, and many cases of tuberculosis which seemed to have been there developed. The last is particularly noticeable among servant-girls of foreign birth. In the experience of physicians in some sections, it is rare to find a servant-girl living and working in a low basement who has good health, though previous to coming to this country, and being subjected to such conditions, good health is stated to be the general rule. Many people have attacks of sickness, following a time of exposure in a basement, with great regularity.

Would it not be better for house-builders and architects to plan for dwellings built more above-ground? More of a lot has to be sacrificed, but perhaps enough may be saved in healthfulness and stair-climbing to compensate for the loss. City yards are of slight value at best. A good cellar is gained by such a change, and up-stairs dining-rooms and kitchens are not only luxuries, but, it may be argued, almost necessities.

SKETCH OF CHESTER S. LYMAN.

IN the company of Puritans who, in the severe winter of 1635, traveled from Massachusetts Bay through the wilderness and settled at Hartford and Windsor, was Richard Lyman, who had come over from England four years before in the same ship with John Eliot, the Indian Apostle, and who, through his two sons Richard and John, was the ancestor of all the Lymans in America. Nearly two hundred years later, in the little country town of Manchester, ten miles from Hartford, CHESTER SMITH LYMAN, his eighth lineal descendant, was born January 13, 1814, the son of Chester and Mary Smith Lyman.

He had in his boyhood only the advantages of a common country school, and, like other country boys, alternated going to school with working on the farm. Before he was nine years old he evinced unusual mechanical ingenuity, making many curious toys, windmills, water-wheels, and the like, which rendered him a favorite with his playmates. He also began soon to show a great interest in astronomy and the kindred sciences, which was first awakened by an intense curiosity to know how a common almanac was made. Books of all kinds in that town were then rare, and of scientific books there were almost none; but he managed somehow to get hold of a few—one on natural philosophy, one on surveying (Gibson's), and one on navigation (Bowditch's)—to borrow the last of which he walked five miles. From one of these he learned the nature of lenses, and soon extemporized for himself a rude telescope by means of his mother's spectacles, a small burning-lens, and a yard-stick. In later life he said, "I can never forget the delight with which I turned this upon the Pleiades, and for the first time saw this cluster expand into a large number of brighter stars." From Gibson and Bowditch he learned, without a teacher, the rudiments of geometry and trigonometry, and in due time obtained a good knowledge of surveying and navigation.

When he was thirteen a copy of Ferguson's "Astronomy" fell into his hands, and was devoured by him as eagerly as most boys read "Robinson Crusoe." He also had access to the articles "Astronomy," "Optics," and some others, in the "Edinburgh Encyclopædia." From thirteen until he was sixteen, except the twelve weeks of Latin mentioned farther on, he spent most of his spare time either studying, entirely without assistance, or in a little tool-shop of his father's, constructing astronomical and other instruments which he had never seen except in the diagrams of his few much-prized books. Among these instruments, which were mainly of wood, were a quadrant, sextant, terrestrial and celestial globes, orrery, eclipsareon, solar microscope, and many others. He also constructed a reflecting Herschelian telescope four feet long, which enabled him to show Jupiter's satellites and belts, Saturn's rings, the moon, and other celestial objects, to the country-folk who came from miles around to look through it. He computed all the eclipses for fifteen years to come, and made almanacs for 1830 and 1831. In order to give the places of the planets in these almanacs (never having seen a nautical almanac or astronomical tables of the planets), he made rough tables for himself, computing them from the elements of the planet's orbits as given in his book on natural philosophy. When about fourteen he with five other boys was made the subject of an experiment in teaching Latin, which impressed him with a life-long conviction that, in the ordinary methods of teaching the classics, one half the time at least is unnecessarily wasted.

The Rev. V. R. Osborn had recently started in Manchester a school in which he aimed to apply what was then widely known as the Hamiltonian system of instruction to the classics—a system, in the main, advocated by Milton and Locke, as well as by other high authorities in education, from Cardinal Wolsey and Erasmus down to Hamilton, who used it in the early part of this century. In order to settle a controversy in the Hartford papers as to the merits of the system, it was suggested that it should be applied in teaching a class of boys who knew absolutely no Latin. Accordingly, young Lyman (not then a member of the school) and a few others were invited to form the class. At the first meeting the first six lines of the "Æneid" were slowly read and translated by Mr. Hart, the teacher, with explanations, the boys one at a time repeating the translation after him, sentence by sentence, until all had gone over the lesson. It was afterward made familiar by using an interlinear translation prepared for them by Mr. Hart. These lessons being gradually increased in length, the first three books were soon read. With their review a Latin grammar for the first time was used, which, now that the text was understood, proved a fascinating exercise instead of the usual bugbear. With this start the remaining nine books were read by means of the *clavis* of the Delphin edition of Virgil, as Mr. Hart's translation then only included three books.* The whole "Æneid" was thus completed in twelve weeks, at the end of which an examination of the class by a professor at Trinity (then Washington) College, Hartford, was pronounced highly creditable, and excited much interest at the time.

Two or three years later several of the leading men in Manchester, together with Major Bissell, an army officer, having become interested in Lyman's mechanical and scientific pursuits, and wishing him to have the advantages of a thorough education, sent an application to the Secretary of War for a cadetship at West Point. There was every prospect that the appointment would be given him, but, before the requisite time had elapsed, he, having become interested in religious matters, determined, instead of entering the military profession, to go to college with a view of becoming a minister. He had now reached the age of eighteen, had taught school two winters in his native town, and been active in a society which he had started for debate and literary practice, giving occasional lectures on scientific and other subjects. He had, withal, fallen into the habit of occasionally writing verses, which now and then got into the newspapers. This habit, begun at the age of ten or twelve, followed him to college and on occasions through life. Entering, in June, 1832, the Ellington School, then one of the most prominent preparatory schools in New England, he fitted for college in twelve months' time, entering Yale in 1833, without conditions.

During his college course he took several literary prizes; and in his junior year he was one of the originators and editors of the "Yale Literary Magazine," being associated with W. T. Bacon, W. M. Evarts, and others. In addition to his regular studies, in which he took high rank, he continued through his course his scientific pursuits, being assistant to the Professor of Natural Philosophy and having access to the observatory, from which he saw, among other objects, the famous Halley's comet at its return in 1835.

On graduating in 1837 he declined several eligible positions, among them a professorship in a Western university, a place in the Wilkes Exploring Expedition, an examinership in the Patent-Office, etc., and became for two years Superintendent of the Ellington School, among his immediate predecessors having been Hon. Alphonso Taft, of Cin-

* This translation was subsequently completed and published in Baltimore, with the names of V. R. Osborn and Levi Hart on the title-page, and serves to this day as a pony for students in Virgil.

cinnati, and Professor John L. Taylor, of Andover. After studying theology in Union and Yale Seminaries, and holding a short pastorate over the First Church in New Britain, Connecticut, he was obliged to travel for his health.

After a seven and a half months' voyage in a sailing-vessel he reached the Sandwich Islands *via* Cape Horn in May, 1846, where he remained a little more than a year. While there, he visited and mapped the volcanic crater of Kilauea, which he afterward described fully in the "American Journal of Science."

While staying at Hilo, in the family of Mr. Coan, the missionary, the unusually large rainfall on that side of Hawaii (over ten feet annually) led Mr. Lyman to construct an ingenious self-registering rain-gauge, which, by means of clock-work, drew a line on a ruled diagram, showing the time of day and all the circumstances of the rainfall.*

During his stay at Honolulu, Mr. Lyman was called upon to teach the Royal School for a few months, having among his pupils four young chiefs, who later successively occupied the Hawaiian throne, and also the chiefess who was afterward Queen Emma.

Just before leaving the islands for California, Mr. Lyman bought an outfit of surveying instruments from his friend Chief-Justice Lee. With these instruments he arrived, in July, 1847, at San Francisco, just then newly laid out among scrub-oaks and sand-hills, and adopting that name instead of its previous one of Yerba Buena. He found it a small settlement, and the only one of its streets on which there were enough buildings of any sort to show which way it ran was Montgomery Street, which then was at the water-front, and in one place was covered with water at high tide, but now is many blocks inland.

Having been commissioned as surveyor by Colonel Mason, the military governor, Mr. Lyman soon found himself fully occupied in the survey of ranches and towns in various parts of California, especially in the country between San Francisco and San José. Among these was a resurvey of the city and adjacent lands of San José (which had been fraudulently laid out by his predecessor, so that many of the lots existed only on his chart), and also the original survey of the famous New Almaden mine, probably the richest quicksilver-mine in the world.

In May, 1847, while he was engaged in surveying the town of San José, there came reports, at first uncredited, that gold had been discovered at Sutter's Mill, on the American River, a hundred and fifty miles or so up in the mountains. At length, a man who had come from the diggings showed some gold specimens in a store at San José, and, the report being at last believed, men began soon to flock to the

* One peculiarity of this rain-gauge was the device by which, in extra heavy rainfalls, which would more than have filled the reservoir, a valve, by which it was emptied, automatically opened and closed, bringing the recording pencil back to zero.

mines. When Mr. Lyman's assistants, who were earning twenty-five dollars a month, heard that their friends at the mines were making as much each day, they also were for starting immediately. Mr. Lyman induced them to finish the work in hand by the promise of going with them if they waited, which was indeed his only alternative, as no more assistants were to be had.

Accordingly, in June, he with a small party started for the mountains, in reaching which they had many difficulties to encounter. Having learned that in order to cross the Strait of Carquinez, which lay in the regular route thither, they must wait three weeks at the ferry, to take their turn with the crowds of gold-seekers already before them, they decided to take a bee-line across the flooded San Joaquin Valley. This they accomplished by improvising a unique boat out of a wagon-body, set into an envelope of rawhides, which they had obtained from wild cattle shot on the way and sewed together for the purpose.

After many other rough experiences of this kind, they reached Sutter's Mill in about a fortnight.

Though they found the district already overrun with diggers, they succeeded in extracting for themselves amounts of gold varying from fifteen to a hundred dollars each daily. The extraordinary price of provisions and all useful articles naturally used up much of their profits—potatoes, sugar, coffee, etc., costing a dollar a pound (and later three dollars !); butter, a dollar and a half a pound ; shovels, ten dollars a piece ; milk-pans, five to ten dollars ; shirts, as high as twenty-five dollars each, etc.

From the mines Mr. Lyman sent to the East some of the first authentic accounts of the gold discovery, which produced much excitement, and found their way into many newspapers. One account was published in "The American Journal of Science."

But life in the gold-region being exceedingly rough, Mr. Lyman after about two months left them, and resumed his work of surveying, which he continued until, with entirely restored health, he returned to New Haven *via* Panama, in 1850.

Being married in that city, in June of the same year, to Miss Delia W. Wood, a daughter of the Hon. Joseph Wood and granddaughter of Chief-Justice Oliver Ellsworth, he settled permanently in New Haven, engaging in scientific and literary pursuits, among which was the preparation of the definitions of scientific words for new editions of Webster's Dictionary. In 1859 he became Professor of Industrial Mechanics and Physics in Yale College, taking an active part in organizing the Sheffield Scientific School, in which he also taught astronomy, and in the early years of the school rhetoric and moral science. In 1871, with the growth of the school, he was relieved of mechanics, and his professorship was changed to that of Astronomy and Physics. On account of impaired health, he resigned the chair of

Physics in 1884, but still retains the Sheffield professorship of Astronomy, of which science he has been the instructor from the organization of the school in 1860.

He spent the summer of 1869 in Europe, for the purpose of collecting mechanical and physical apparatus for the school, and of visiting scientific institutions. He has been a contributor to "The American Journal of Science," "The New-Englander," and other periodicals, and is the originator of various useful inventions, among which are the wave apparatus known by his name, patented and manufactured by Messrs. Ritchie & Sons, of Boston, and a pendulum apparatus for describing Lissajou's acoustic curves, constructed several years in advance of a similar apparatus made in London by Tisley & Spiller.

Professor Lyman is the original inventor of the combined transit instrument and zenith telescope for determining latitude by Talcott's method. This instrument was designed and mainly constructed in 1852–'53, and numerous observations together with a description of the instrument were published in "The American Journal of Science" and elsewhere, some ten years before the construction and published account of a like instrument by Davidson.* His aptitude in practical mechanics was of much service to him in devising and constructing apparatus for the lecture-room.

Professor Lyman has been actively interested from the first in the establishment of the Yale Observatory, and is one of its board of managers. His attention has been much given also to practical horology, and some improvements of his in escapements and compensation pendulums have proved practically valuable. He was the first to observe Venus as a delicate ring of light when very near the sun in inferior conjunction, as in December, 1866, and also before and after the transit of Venus in 1874.

He is a member of various scientific and literary bodies, among them the British Association for the Advancement of Science, and was for twenty years President of the Connecticut Academy of Arts and Sciences.

Mr. Lyman's life-work has been mainly teaching. He has the quality so necessary in a successful instructor—that of explaining difficulties with great clearness and patience. His uniform practice of treating his students as gentlemen rather than school-boys, and trusting to their sense of honor, has gained for him their universal respect and affection.

* This instrument has been in use for many years, and known by Lyman's name, in the governmental survey of India.

CORRESPONDENCE.

DISSECTION OF A GLASS-SNAKE.

[SOME weeks ago Messrs. O. R. Glover and Charles H. Lawrence, of Chicago, favored us with a living specimen of joint- or glass-snake, which had been captured on a farm owned by them in Starke County, Indiana. With a view of obtaining, if possible, any facts in addition to what was published in the Correspondence department of the "Monthly" for February and April, and in the Popular Miscellany department for the latter month, the creature was sent for examination to Dr. W. A. Conklin, Director of the Central Park Menagerie, New York, who has kindly furnished the following report.—Ed.]

Editor Popular Science Monthly:

SIR: I delayed sending you any report on the chain-snake (*ophibolus*) for the following reason: Shortly after reaching the menagerie the snake laid a number of eggs, and, as I had some curiosity to see if they would be hatched, I decided not to disturb it for a few days. It remained six days coiled around the eggs, leaving them for a short time each morning to drink water. On the seventh day it was found dead. The theory that a full-fledged vertebrate animal such as this should possess power of unjointing and rejointing itself seems hardly worthy of discussion. I sent the specimen to Dr. W. S. Gottheil for dissection, and he writes me as follows: "There is a vertebral column, running the entire length of the animal, the individual segments of which are accurately fitted together, bound to each other by a complicated and firm system of ligaments, and containing continuous nerve-structures; here are muscles running from bone to bone, long internal organs, intestinal canal, liver, etc., and covering the whole is a perfectly continuous and very tough dermal envelope. There is no more possibility for it to unjoint than for a person to unjoint his head from his trunk. One peculiarity only is noticeable: the cloaca is very high up at the junction of the anterior and middle thirds of the animal's length, and the tail-piece is thus relatively very long."

I believe that in some of these animals the terminal segments of the body are neither so firmly attached nor so highly vitalized as the rest, and can be detached by a comparatively slight amount of violence, and without entailing any disability upon the animal. The tail being exceptionally long here, it may be that a comparatively large section of the body may become detached by a blow. The animal could not break into several pieces, and it certainly could not unite if it could do so.

W. A. CONKLIN,
Director of Central Park Menagerie.

FICTIONAL ASTRONOMY.

Editor Popular Science Monthly:

SIR: I note the letter of Anne M. Johnson, in the September number, on the astronomical mistake in "King Solomon's Mines." She is quite right in saying that others, besides Mr. Haggard, may make errors in regard to the moon. Here is an instance from so careful a writer as Andrew Lang: In his "Letters to Dead Authors," he tells Theocritus, "Thou wouldst see the dawn awake in rose and saffron across the waters, an Etna, gray and pale against the sky, and the setting crescent would dip strangely in the glow on her way to the sea." This is the reverse of the mistake made by Mr. Haggard and Anna Bowman Dodd. Edward King, in his recently-published poem, "A Venetian Lover," also says (line sixteen), "The young moon pales before approaching dawn." Many other similar instances might be quoted, some from rather unexpected sources.

But Mr. Haggard excels all competitors in that his error of making the crescent moon rise soon after sunset is only one of a series. By referring to the book, it will be seen that the very next night "the full moon rose in splendor about ten," without any explanation of the change from "crescent" to "full" in some twenty-four hours, or of a full moon rising so late in a country which seems somewhere near the tropic of Capricorn. Following the narrative a little further, we find that, on the succeeding day, there is an eclipse of the sun, with total darkness for nearly half an hour. As it is hardly necessary to mention, an eclipse of the sun can take place only at new moon, and the total obscuration never lasts more than a very few minutes—four, if I remember rightly. It will be seen that Mr. Haggard has made the most of his opportunities for blundering.

EDWARD H. BEEBE.

CHICAGO, *August* 31, 1887.

ANOTHER ANOMALY IN PLANT-GROWTH.

Editor Popular Science Monthly:

SIR: To the illustrated letter of E. W. B. Canning, in your September number, entitled "An Anomaly in Plant-Growth," I would add this description of a case observed at "Harmon's Bottom," in Bedford County, Pennsylvania, twenty years ago. Two sugar-maples had been united by the natural grafting of the branch of one of them upon the trunk of the other, about six feet away, and at ten feet above the ground. The tree-trunks were both intact, with their roots, but the trunk of the second tree was strikingly smaller below the graft than above it, and one might consider this due to retardation of the circulation below, as well as increased flow of sap above. In your correspondent's illustration, the trunk below, being severed from its roots, became an appendage to the rest of the circulating system. It has been speculated that there is circulation downward in plants, the roots discharging to as well as eliminating from the soil, and that this action unfits a soil as much for repetition of crops as does exhaustion of nourishing constituents. The preference for change in kinds of trees that spring up after forest-clearing—a natural rotation of crops—has been very generally remarked. F. Z. SCHELLENBERG.

IRWIN, PENNSYLVANIA, *September* 3, 1887.

WHAT IS A BAYOU?

Editor Popular Science Monthly:

SIR: A friendly, well-meaning, and timely correction is never amiss. When the error to be rectified is such as is likely to arouse feelings of regretful remonstrance in a community, the correction is the more pardonable; when it is likely to color the opinion of a nation, the correction becomes imperative.

The correction which the writer, one of a "community" supposed above, would most humbly beg leave to make, is to an error that the writer of a most able and interesting article in the July issue of "The Popular Science Monthly," entitled "The North American Lakes," has doubtless unwittingly been guilty of. I do not presume to say that he was led to the commission of the error by any ignorance of his subject, but rather by a want of a sufficient knowledge of the local nomenclature of Louisiana.

To quote the author's words—"Lake Borgne and Lake Pontchartrain have been captured from the Gulf by the delta of the Mississippi, while numerous small lakes, called bayous," etc. We will say nothing of the derivation of the word, which, of itself, can not be construed to mean a lake, for, alas! local usages frequently defy all attempts at classification, and are by no means fair criteria for the true meaning and application of a term; but, as a Louisianian, we will say that the term "bayou," in the article cited, has been used under some misapprehension.

If the author will procure for himself an authentic map of Louisiana, he will find the lower part of the State to be covered with almost a network of small water-courses, although they scarcely deserve the name, varying in size from the smallest "creek" to channels just navigable by small vessels, all exceedingly sinuous and very river-like. These are what, in Louisiana, are called "bayous." Whatever may be the geological origin and nature of these bodies, the fact still remains that the term "bayou," in Louisiana, is applied to nothing at all resembling a "lake." Respectfully yours,

C. M. WILLIAMS.

CARROLLTON, LOUISIANA, *September* 5, 1887.

EDITOR'S TABLE.

SCIENCE IN HARNESS.

NO journal has upheld more steadily than "The Popular Science Monthly" the principle that, as fast as they are established, the truths of science shall be applied to useful purposes, and, through popular education, be made as widely available as possible for the general guidance of life. And yet we can not look with favor upon what many persons doubtless regard as a very signal and happy example of the utilization of scientific conclusions—we mean the authoritative and dogmatic teaching as to the effects of alcohol, now provided for by the school laws of many States. It is only right, therefore, that we should assign our reasons for holding that this is not a case of the legitimate application of scientific truths to practical life.

In the first place, it is an abuse of power on the part of the majority. In the "temperance" controversy as a distinct social issue we have no wish to interfere; but we can not ignore the fact that there is such a controversy, nor can we consent to believe, with the advocates of prohibitory legislation, that their opponents are necessarily persons devoid of all high motives, and hardly to be distinguished from the criminal population. But if a minority in the State is to be respected so long as it is law-abiding, its opinions are also to be respected; and to seize hold of the school-machinery of the State to inculcate opinions that are not accepted by the minority, and that tend to set the minority in a very unfavorable light, is not right or just. If every triumphant party were to seize the public schools for the inculcation of doctrines favorable to its own party interests, there would soon be an end of our public-school system. It would always be easy to invoke the name of science. If it were desired to rear a race of protectionists, it would only be necessary to claim that you were teaching the truths of political economy. The proper text-books would be prepared, and teachers, on pain of dismissal, would have to enunciate the doctrines of Henry C. Carey and Horace Greeley. And so in the days of slavery the science of ethnology might have been invoked either on the side of abolition or in defense of the slave system, according to the leaning of the majority. At this moment we have the president of a New England college recommending the majority in the several States to use their power to enforce the teaching of certain specific views of New Testament history which he is pleased to declare all competent critics have accepted.

"But," say the advocates of the teaching to which we refer, "we only wish to inculcate the real results of scientific research in regard to alcohol." To which we rejoin that, in a community like this, it is too soon to inculcate the truth, supposing you have it, if the issue is still practically open, and if large numbers of your fellow-citizens are not persuaded that what you call the truth *is* the truth. Minorities have their rights even when they are in the wrong, and to use a school system which the minority support to teach opinions which the latter do not believe to be true is unfair.

But there is another view of the matter. Are the advocates of such instruction prepared to have it communicated in a thoroughly non-partisan spirit? Are they prepared to have the whole truth taught, or do they want only that part of the truth which is favorable to the specific end they have in view? Are they prepared, for example, to give any fair representation to the views of those who consider that alcohol has its important uses, dietetic and social? A few years ago the "Contemporary Review" opened its columns to a discussion of the alcohol question; and we are safe in saying that there was a preponderance of opinion among the many eminent men who joined in the discussion, in favor of a moderate use of alcoholic beverages. In the August number of the "North American Review" a well-known physician of this city enters a plea against the indiscriminate condemnation of narcotics and stimulants. Is all this opinion to go unrepresented when the alcohol question is introduced into the schools? Of course it must, or the specific object of the teaching would be ruined. We say, therefore, that this is not teaching science; it is harnessing science to the "temperance" cart, and driving her under instructions from "temperance" headquarters.

We need not, however, confine ourselves to general speculations as to what is likely to happen when science is made subservient to the propagation of special views, for we have an example—and a striking one—of what *does* happen in such a case. In a recent number of the "Boston Medical and Surgical Journal," Dr. Joseph W. Warren, assistant in physiology in the Medical School of Harvard University, gives an account of a pamphlet on the subject of "Alcoholic Liquids as Therapeutic Agents," issued by the Women's Temperance Publication Association of Chicago. This pamphlet, it is true, consists of a chapter from a larger work on the "Principles and Practice of Medicine"; but the chapter in question was selected for use as a tract because it states the case against alcohol with all the exaggeration and suppression needed for party purposes. Dr. Warren describes it as "full of error and misstatement concerning the physiological action of alcohol," while "the therapeutic inferences drawn therefrom are, to say the least, most doubtful." One example will suffice to show to what extent—if we may trust Dr. Warren, who writes with a very full command of his subject—the truth has been economized in the pamphlet in question. The author, after stating that "the experimental researches of Lallemand. Perrin, and Duroy proved conclusively that alcohol was eliminated as alcohol, unchanged chemically, from the lungs, skin, and kidneys," adds that these experiments have been confirmed, except that it is claimed that "the amount eliminated is not equal to the whole quantity taken." "Surely," says Dr. Warren, "no beginner would infer from the last quotation that *every competent investigator* had found the amount eliminated, not only *not equal to the whole quantity taken*, but really to form only a small fraction of it; yet such is actually the case." We have not space to follow Dr. Warren in his very thorough examination of this anti-alcohol manifesto; but we very heartily concur with him in some of his concluding remarks. "There are times," he says, "when it may be well not to tell the whole truth; but I have yet to learn how the human race can be benefited, in the long run, by systematic deception, and by the wholesale circulation of what is, to say the least, not true." Again: "The temperance movement of the future will have to recognize that the field for its activity lies not in the dissemination of falsehood about what alcohol is and does, but in the control of its rational use and in the prevention of all abuse. Intemperance is a terrible weed, but its roots will be found to be entangled amid many social problems of heredity, poor food, overwork, bad cooking, and bad homes, all quite as important, if not more important, than the question of alcohol." The main object of the present article, however, is to protest, in the name of science, against the tethering of it to any party policy whatever; and in the name of social and political justice against laying hold of the public schools for the propagation of opinions based as yet upon very incomplete inductions. Our temperance reformers have ample scope for a wise and beneficial activity without seeking to control the schools and without perverting opinion by the dissemination of unfounded statements under the guise of science.

A FURTHER ADVANCE.

We noticed, at the time of its appearance, an article by the celebrated Roman Catholic biologist, Mr. St. George Mivart, claiming for members of the Catholic Church the fullest liberty of opinion in all matters pertaining to science. In Mr. Mivart's opinion, it was a fortunate thing for the world that the Church had blundered so egregiously in condemning and punishing Galileo for putting forward the true theory of the heavens. It was a lesson that the Church would not be likely to forget as to the expediency of minding its own business; and it was an instance to which the laity could always appeal in case ecclesiastical authority should ever seek to set itself up as a judge of scientific questions. To-day, after a lapse of two years, Mr. Mivart comes forward with another plea for liberty—this time in connection with questions of history and criticism. He states that, in writing his former article, he purposely expressed himself very strongly, in order that, if there was anything in the position he took of a nature to call for ecclesiastical censure, he might hear of it; but that, far from having been visited with censure, he had received "warm thanks from members of the clergy, most varied as to rank and position," and particularly from "a most esteemed superior of one of the mediæval religious orders." He therefore feels that it is time to take another forward step, and say that, in matters of historical and Biblical criticism, the only appeal must hereafter be to facts. It will not suffice to say that such and such statements are contained in Holy Writ, or have formed part of the ordinary teaching of the Church; the only pertinent questions will be: Are they true? Are they supported by such evidence as challenges the assent of impartial inquirers? He then proceeds to give a summary of the leading conclusions of such advanced Biblical critics as Reuss, Colenso, Wellhausen, and Kuenen, and states that, while he is not prepared—does not, indeed, feel himself competent—to say that the views of these eminent men are correct in every particular, he is convinced, after careful inquiry, that they are correct in the main. He considers that these men occupy, in relation to Biblical criticism, very much the same position that Copernicus occupied in relation to the astronomy of his age; and that, just as the world accepted the views of Copernicus when it became intelligent enough to understand them, so the world will eventually adopt the views of the liberal school of Biblical critics. How far these writers go may be judged (in one instance) from Mr. Mivart's statement that "the book of Chronicles is considered (by them) as a thoroughly unhistorical work, the history contained in it being habitually falsified in accordance with the point of view of the priestly code." According to Mr. Mivart, it is quite open to the members of the Catholic Church to accept these views, and, in all such questions, to yield simply to the weight of historical evidence. "It is," he says, "the men of historical science now, and not theologians or congregations, who are putting us in the way of apprehending, with some approach to accuracy, what the truth is as to the dates, authorities, and course of development of the writings which were inspired for our spiritual profit."

We presume Mr. Mivart will now wait to see whether ecclesiastical censure will fall upon him for this last utterance. He says he does not think it will. He has reason to believe that "broad views are not in disfavor at the Vatican, though sudden or abrupt action is neither to be expected nor desired." It seems, then, to be a question as to whether that section of the Christian Church which has hitherto been accounted most conservative of traditional opinions, and most resolutely hostile to all the new views of science, is not in reality destined to prove itself the most hospitable and friendly to such new views. The situation is a singular one, and merits the attentive consideration of some excellent people who consider their theology a great advance in point of liberality and rationality upon that of Rome, and who yet have an evil eye for such scientific doctrines as that of evolution, to say nothing of a free critical handling of the sacred texts. On the subject of Biblical criticism we have no opinions to offer; but we must say that we feel like agreeing with Mr. Mivart that, in this field, as in every other, the authorities to be deferred to are those who have a competent knowledge of facts, not those who are merely the official conservators of ancient dogmas.

LITERARY NOTICES.

Appletons' Physical Geography. By John D. Quackenbos and others. New York: D. Appleton & Co. Pp. 140. Price, $1.60.

This work has been prepared on a new plan. Physical geography, comprising parts of a number of sciences, covers a wider field than one man can be thoroughly familiar with; hence, in order to secure the advantage of special knowledge over the whole field, this work has been written by several hands. The section on the general structure and geological history of the earth has been prepared by Dr. John S. Newberry, Professor of Geology and Paleontology in Columbia College; that devoted to the geological history of the North American Continent, by Professor Charles H. Hitchcock, of Dartmouth College; the portion relating to general physiology and the physical features of the United States, by Mr. Henry Gannett, Chief Geographer of the United States Geological Survey; the pages explaining terrestrial magnetism, with the chapters on volcanoes and earthquakes, coral islands, the earth's waters, and meteorology, by Dr. W. Le Conte Stevens, Professor of Physics in the Packer Collegiate Institute. Dr. N. L. Britton, Lecturer in Botany, Columbia College, furnished the chapter on plant-life; Dr. C. Hart Merriam, the Ornithologist of the Department of Agriculture, those relating to zoölogy and the animal life of the United States; Professor William H. Dall, of the Smithsonian Institution, that on ethnology; and Mr. George F. Kunz, gem expert and mineralogist with Messrs. Tiffany & Co., of New York, that on precious stones. Throughout the book references to standard works have been inserted, which will guide pupils and teachers to fuller sources of information on the various topics which can be only touched upon in a school text-book. The text is copiously illustrated with pictures, diagrams, and maps in color, on which no pains have been spared to secure accuracy and mechanical excellence.

The Printing of Cotton Fabrics, comprising Calico Bleaching, Printing, and Dyeing. By Antonio Sansone. Manchester, England: Abel Heywood & Sons. Pp. 375, with Nineteeen Plates, Thirteen Text Illustrations, and Eight Plates of Printed Samples.

The applications of new chemical discoveries to technical purposes have become so frequent during the last quarter of a century as to cause almost a complete change in several important branches of modern industry, developing new fields of human application and effecting marked improvements in manufacturing generally. Like other industries, the colorist branch, which may be said to be the pet child of modern chemical investigation, has not been slow to feel the effect of the introduction of scientific methods in the every-day work of the factory; the result has been a steady progress and improvement in the methods of obtaining colors on fabrics, consequent on the introduction of new coloring-matters and a better understanding of the properties of the substances used, and of the principles which govern the formation and fixation of each color on the fiber.

The printing of tissues—that is, the art of fixing various colors which form more or less elaborate designs on cloth—is a very complicated process, requiring for its successful completion the assistance of all the skill which chemical and mechanical progress has placed at the service of manufacturers. This progress, however, which permits of greater facilities being introduced gradually, rendering possible the adoption of novel and more complicated designs which could not be easily employed with older methods, makes it at the same time imperative on those engaged in this branch of industry to keep themselves posted on all the forward steps made by others, in order to meet the artistic requirements of the consumer, and the competition of rival manufacturers.

This progress is so steady and gradual that it has to be followed incessantly. Publications treating specially of this branch of manufactures are not very plentiful; the continual changes and improvements are liable to deprive a book of its practical usefulness a few years after its publication. A complete work on the subject, embodying the latest devices and processes in use, can, therefore, not help being welcome both to the trained colorist and to the student. The author is well fitted for the task he has undertaken, having been for several years director of the School of Dyeing and Printing at the Technical School of Manchester, the center of the printing industry.

Theory and practice are given an equal share of attention, which they both deserve in an art in which scientific training, skill, experience, and artistic taste have all to contribute to the result. The opening chapter is devoted to the history of calico-printing which is traced from its origin in India, to its present flourishing expansion.

Before the tissue can actually be printed upon, it is necessary that it should be bleached; to this important preliminary operation an interesting chapter is devoted. The colors and materials used by the calico-printers are many, and are divided into three classes—colors, mordants, and thickening materials. The colors are divided as follows: mineral colors, the importance of which has largely decreased of late in calico-printing; natural organic coloring-matters, such as logwood, madder, indigo cochineal, berries, etc., which are used chiefly under the form of extracts; artificial coloring-matter, or coal-tar colors. The origin, properties, chemical composition, etc., of each coloring-matter are given. The mordants include all those substances possessing the property of causing coloring-matter to become fixed on the fiber, either by precipitation, adhesion, or otherwise. Salts of alumina, iron, chrome, tin, lead, zinc, antimony, etc., possess mordant properties, and occupy an important place in the preparation of the print colors. Tannin, soaps, oils, etc., are also extensively used.

Thickening materials are indispensable to the calico-printer. In order to prevent the colors on the cloth "running" into each other, and to obtain a distinct separation between the different shades, all the printing-colors have to be thickened. This is done by means of starch, gum, albumen, etc. The colorist has to be thoroughly familiar with the properties of all the substances he uses, and with their action toward each other. Considering that some of the print-colors have to be composed by mixing together from six to ten different materials, the knowledge of the properties of each is important. A short chapter is devoted to water. The most important part is that devoted to the printing processes, the practical work of the colorist. It includes chapters on preparing thickenings; preparing mordants; steam-colors (steam pigment-colors; steam aniline-colors, steam alizarin-colors, dyewood, redwood, catechu, and compound steam-shades); steam mineral colors; a chapter on steam-colors of the most recent introduction, and on new solvents; oxidation-colors, colors obtained by reduction; dyed colors, the designs on which are obtained by resisting and discharging processes.

The machinery and apparatus employed in calico-printing are described in another chapter, and illustrated. The illustrations are many, and represent the most important apparatus which are in use in print-works. The most complicated of these is the twelve color printing-machine, by means of which the most complicated and elaborate designs can be produced on cloth.

Short chapters are devoted to the finishing of printed goods; electricity in printing; and printing woolen fabrics.

A table, showing the principal styles of calico-printing, and the number of shades that can be produced in each style, is also given. Besides the numerous illustrations the volume contains eight plates of printed samples of calico, chosen so as to show the different styles.

Taken altogether, the volume under review contains a very large amount of practical information. The student will find in it a complete guide in his first attempts at laboratory work in the branch he chooses to follow, while the expert colorist can rely upon it as a valuable reference-book.

Romantic Love and Personal Beauty: Their Development, Causal Relations, Historic and National Peculiarities. By Henry T. Finck. London and New York: Macmillan & Co. Pp. 560. Price, $2.

Many sober-minded persons would expect a book on romantic love and personal beauty to contain nothing better than silly sentimentalism, if happily it contained nothing worse. But these two closely connected subjects have other aspects than the sentimental one. Romantic love, by which is meant, in this book, the complex emotion that leads a civilized person, free from considerations of policy, to desire marriage with a particular individual, has a powerful influence in directing the development of the race. For the feelings that determine the choice of partners in marriage determine also what physical, mental, and moral characteristics shall be brought together and transmitted to the next generation. The design of Mr. Finck's book is to analyze romantic love and personal beauty, and to trace their development and history. In what he calls a "chemical" analysis he compares love to a musical note, composed of the sexual relation as its fundamental tone, with eleven overtones, viz.: individual preference, monopoly or exclusiveness, jealousy, coyness, gallantry, self-sacrifice, sympathy, pride of conquest and possession, emotional hyperbole, mixed moods—major and minor—and admiration of personal beauty. Love thus constituted, he maintains, is unknown to savages, and was not experienced even by the civilized peoples of antiquity. In fact, he affirms that animals approach nearer to the emotion of romantic love than savages, for many animals, especially birds, have a period of courtship in which they display at least four of the "overtones" of romantic love, viz., jealousy, coyness, individual preference, and admiration of personal beauty, while savage men obtain their wives by capture or by paying a price for them in goods or labor, without any preliminary love-making. Even among ancient civilized nations he maintains that romantic love could not exist, because women then held a degraded position, and were carefully secluded both as maids and matrons, marriages being arranged for by the parents of the young people, thus allowing no opportunities for courtship and for free matrimonial choice. Among his evidence for this thesis is the statement that there is no mention of romantic love in the Bible, not excepting the Canticles. He disposes of Herder, who has asserted the opposite, by calling him "a very unsafe and shallow guide in this matter," and says, "So far as love is referred to in the Song of Solomon, it is probable that conjugal affection is meant." He makes a sharp distinction between conjugal and pre-matrimonial love, in which many persons will not agree with him, and claims that the former is developed earlier in the history of all peoples than the latter. Mr. Finck sees no evidence of a knowledge of romantic love in the verses of Anacreon or Sappho, of Catullus or Ovid, nor in the deification of Eros and Cupid. He does credit Ovid with depicting an approach to romantic love, but this approximation was soon lost to the world, and the sentiment remained unknown throughout the dark ages, even including the period of chivalry, which much-lauded institution Mr. Finck deems to have been less refined in practice than in theory. According to our author, romantic love began its existence A. D. 1274, in the breast of Dante, when he was a nine-year-old boy, and its advent is described in the "Vita Nuova." But Mr. Finck says that Dante "hyper-idealized his passion," and that it was Shakespeare who first mingled the sensuous, æsthetic, and intellectual elements in proper proportion; next to Shakespeare's poetry, he deems Heine's the most valuable depository of modern love. In giving a further detailed account of the genuine romantic sentiment, he touches on the topics, old maids, bachelors, genius in love, kissing—past, present, and future—how to win and how to cure love, and the characteristics of French, Italian, Spanish, German, English, and American love.

In treating of personal beauty he very properly insists on hygienic living, which involves shunning many so-called beautifiers, as the basis of physical beauty, and credits some beautifying influence to crossing, romantic love, and mental refinement. After a short discussion of the evolution of taste, he describes the different ideals of beauty, savage and civilized, for the various parts of the human form, from the feet to the hair, with hints for improving the appearance of each part, and concludes with an examination of national types of beauty.

Mr. Finck supports his various statements with a multitude of analogies, allusions, and quotations. He maintains throughout a playful attitude toward his subject, which leads him into the use of slang and colloquial language in order to make fun; for instance, such expressions as "get left," "high-toned," "sparking," and "stabbed by a white wench's black eye." He is also careless about his syntax, thus he says, "A favorite Slavonic device is to cut the finger, let a few drops of her blood run into a glass of beer," etc., the pronoun having no antecedent. He defines a morganatic marriage as "a special royal euphemy for bigamy," but such a marriage need not involve bigamy. His science is as careless as his language; thus he speaks of existing savages as representing "a later stage of evolution" than existing animals. In short, this book is the production of a clever writer; it is clean and entertaining reading, but it is no addition to our knowledge of a subject which is really worthy of earnest study.

Facts and Fictions of Mental Healing. By Charles M. Barrows. Boston: H. H. Carter & Karrick. Pp. 248. Price, $1.25.

It is a friendly hand which has written these chapters. According to Mr. Barrows's preface, he "is convinced, by the results of many careful tests, that if the mental treatment of disease be not all that its most sanguine advocates picture it, it is a powerful therapeutic agent when skillfully used, and based on a philosophy which has done the world incalculable good." In the opening chapters the author gives as clear an account as could be expected of the somewhat confused and contradictory ideal philosophy and pantheistic creeds of the mental healers, little if any of which appears to be essential to mental healing; "indeed, a majority of the cures of this character," says Mr. Barrows, "have been wrought by persons utterly ignorant of, or disbelievers in, the doctrines of modern psychopathy." He describes a number of cures without medicine effected by regular physicians either by acting on the mind of the patient, or by resigning him to the recuperative power of a strong constitution. None of the cases of relapse or death under mental treatment which have been reported are alluded to by Mr. Barrows, although he mentions that one of the great lights of "Christian science" was recently prostrated with nervous exhaustion, and obliged to seek medical aid; and that another, who had become so enthusiastic as to declare that he could never be sick, died within a year of hæmorrhage of the lungs. The concluding chapters consist of more or less relevant matter drawn from Buddhism, Brahmanism, and the philosophy of Emerson.

Palæolithic Man in Northwest Middlesex. By John Allen Brown. Illustrated. London: Macmillan & Co. Pp. 227.

This contribution to the study of prehistoric man in Britain embodies the substance of papers read before various scientific societies, describing investigations by the author in the northwestern portion of the county which environs London north of the Thames. The river-deposits here run back for about three miles, rising in terraces to more than one hundred and forty feet above the present level of the stream. The author describes and figures a large number of worked flints from the gravels of various levels, as well as similar implements from other sources. He reviews the customs of savage tribes in various parts of the world, who still use stone implements, and from this material constructs a picture of Paleolithic life in Middlesex. As to the antiquity of man in Britain, he concludes that the river-drift hunter of the Thames Valley, entering the British Isles at least as early as the first Continental period, saw the last submergence of the greater part of the British Isles beneath the sea, survived the Glacial period which followed the re-emergence of the land, and, as the glaciers retreated, reoccupied that portion of the country from which the sea and the ice had driven him.

Gilman's Historical Readers. Nos. 1, 2, and 3. By Arthur Gilman. Chicago: The Interstate Publishing Company.

The making of books for young persons is not always an easy matter, and this is conspicuously the case with historical books. Most of the short and concise histories intended for school use are so condensed in matter, so filled with details and with useless names and dates, that they but poorly fulfill the purpose for which they are written. The true end to be aimed at in teaching history to the young is to give them a clear and correct outline view of the history of the leading nations, and impress this view as vividly as possible upon their minds. But too often the books they have to study are so overloaded with detail that the outlines of the whole are lost in the multiplicity of the parts; and thus the attention and the memory are heavily taxed without any corresponding benefit.

The books now before us are not liable to this objection. Mr. Gilman seems to have in the main an excellent idea of what matter and how much should be introduced into a school-book on history. Very few of his chapters are crowded with detail, and for such cases of the kind as do occur there is generally some special reason. The three volumes on American history form a graded series, the first being the simplest and the last the most difficult. The first volume is devoted to the discovery of the continent, and the early voyages before the settlement of North America. The second covers the period of colonization down to the extinction of the French power east of the Mississippi. The third and concluding volume is devoted to the "Making of the American Nation," by which term the author means "the process by which the loosely-connected American communities outgrew their colonial condition of social and political life, and developed into a nation." This process, Mr. Gilman holds, was not completed till after the civil war and the reconstruction of the Union, since it was not until then that the people became one in sentiment in all parts of the land. Throughout his work the author has avoided, for the most part, the details of battles and of political intrigues, which fill so large a space in many historical works, rightly deeming them inferior in importance to those more quiet but deeper movements of society which really determine military and partisan affairs themselves. The book may be heartily recommended to the young, and to all instructors engaged in the teaching of history.

Grasses of North America: for Farmers and Students. By W. J. Beal, Michigan Agricultural College. Published by the author. Pp. 457. Price, $2.50.

The author's aim has been, as is implied in the title, to furnish such an account of the grasses which more commonly come under observation as will be interesting and useful to the farmer and student, as well as to the general reader who has never studied botany. While no attempt has been made to write a complete account of the structure and physiology of grasses, such information is given on these points as will probably be sufficient and satisfactory to the classes of persons mentioned. The first chapter is, in fact, devoted to "The Structure, Form, and Development of the Grasses," and gives intelligible descriptions of their parts and the philosophy of their growth. In the chapters that follow are considered: "The Power of Motion in Plants"; "Plant-Growth" (germination, the functions of green leaves, the plant as a factory, and the composition of plants, particularly of American grasses); "Classifying, Naming, Describing, Collecting, and Studying"; "Native Grazing-Lands"; "Grasses for Cultivation" (under which head thirty-one species are described and figured); "Early Attempts to Cultivate Grasses"; "Testing Seeds, some Common Weeds"; "Grasses for Pastures and Meadows"; "Preparation of the Soil and Seeding"; "Care of Grass-Lands"; "Making Hay"; the improvement of grasses; and "Grasses for the Lawn, the Garden, and for Decoration." Although clover is not a grass, farmers regard it as economically in that category, and a chapter is therefore given to it and other leguminous forage-plants. The treatise is concluded with chapters on "The Enemies of Grasses and Clovers" and "The Fungi of Forage Plants," both of which are well illustrated, a bibliography, and a convenient index. A second volume is in preparation, to contain the descriptions of all the known grasses of North America, with illustrations of one species, and sometimes more than one, in each genus, notes on cultivation, and a chapter on geographical distribution.

Circulars of the Bureau of Education. No. 1. 1887. Washington: Government Printing-Office. Pp. 89.

The present number of the "Circulars" is an account of the College of William and Mary, prepared by Professor Herbert B. Adams as a contribution to "The History of Higher Education." The history of this institution, of which Washington was a chancellor, and Jefferson, Chief-Justice Marshall, and other distinguished statesmen were graduates, is made to suggest several lessons bearing upon the higher education, of which the author emphasizes the ideas of "a college-capital, or at least of higher education, in a municipal rather than in a rural, or even suburban, environment; and the revival of that close connection between education and good citizenship which made the College of William and Mary a seminary of statesmen"—ideas which are considered more specifically with reference to what the author declares to be the greatest educational need of our time—the application of historical and political science to American politics.

A Manual of Weights and Measures. By Oscar Oldberg. Chicago: Charles J. Johnson. Pp. 246. Price, $1.50.

This book is designed for a text-book and a book of reference, and gives information of practical as well as theoretical value on the important subject, with a fullness and method that we have not observed in any other single work. It contains the elements of metrology; the relations between metrological systems and arithmetical notation; a brief review of the development of weights and measures; the demands of practical medicine and pharmacy in the matter of subdivision of the units employed; the metric system; American and English weights and measures; the relations of weight to volume; specific weight; specific volume; the construction, use, and preservation of balances or scales, weights and measures, and of alcoholometers, urinometers, and other hydrometers; and extensive tables of equivalents. Careful attention has been given to the applications of weights and measures to prescribing and dispensing, and to the construction of formulas for liquid preparations.

The Struggle for Religious and Political Liberty. By Theo. C. Spencer. New York: The Truth-Seeker Company. Pp. 140. Price, 75 cents.

The progress of political liberty occupies but a small portion of this book, which is mainly devoted to pointing out the defects, inconsistencies, and cruelties of the religions of the Western world. The claims of the Bible to be an inspired book are disputed, and it is compared to the Koran and the Book of Mormon. A sketch is given of the chief persecutions of Protestants and Catholics, and of the collisions between various Protestant sects. The Church of Rome is declared to be the chief obstacle to religious liberty.

Nervous Diseases and their Diagnosis. By H. C. Wood, M. D., LL. D. Philadelphia: J. B. Lippincott Company. Pp. 501. Price, $4.

This work is described by the author as a treatise on the phenomena produced by diseases of the nervous system, with especial reference to the recognition of their causes. Dr. Wood classifies nervous disorders under the following heads: Paralysis, Motor Excitements, Reflexes, Disturbances of Equilibration, Trophic Lesions, Sensory Paralysis, Exaltations of Sensibility, Disturbances of the Special Senses, Disorders of Memory and Consciousness, Disorders of Consciousness, and Disturbances of Intellection. The descriptions are clear, and a copious index is appended to the volume.

Dermatitis Venenata: An Account of the Action of External Irritants upon the Skin. By James C. White, M. D. Boston: Cupples & Hurd. Pp. 216. Price, $2.50.

This book is a manual for the medical practitioner, comprising accounts of the action of those vegetable, animal, and mineral substances which produce inflammation of the skin when externally applied, with directions for treating such inflammation. The plants are arranged alphabetically by families, and comprise a hundred species. The irritant action upon the skin of various vegetable products and chemicals is described, and also of the bites and stings of insects.

The Curability of Insanity and the Individualized Treatment of the Insane. By John S. Butler, M. D. New York: G. P. Putnam's Sons. Pp. 59. Price, 60 cents.

The author recommends a preventive treatment in the incipient stages of the disease; lays particular stress upon the advantage of individualization in treatment, or its adaptation to the character and circumstances of individual patients and the manner in which their affection manifests itself; and advocates the separation of curable cases from those which are hopeless.

The Graphical Statics of Mechanism. By Gustav Herrmann. Translated and annotated by A. P. Smith. New York: D. Van Nostrand. Pp. 158, with Plates.

This work is intended to be a guide for the use of machinists, architects, and engineers, and a text-book for technical schools. The graphical method is becoming extensively disseminated in engineering circles, as its advantages over the analytical method are more and more recognized, and its further development is kept constantly in view. Its application has been impeded by the difficulty of taking account of friction and the special hurtful resistances to motion, the calculations of which have hitherto been confined to the analytical method. No method being known to the author by which the frictional resistances and efficiency of any desired mechanism can be graphically determined, he has endeavored, in his lectures before the polytechnic schools of Aix-la-Chapelle, to show the relations existing between the forces in mechanism in a simpler form than that offered by the analytical method. The present treatise, which the translator characterizes as containing "almost discoveries" on the subject, has grown out of that endeavor.

Compressed Gun-Cotton for Military Use. Translated from the German of Max von Förster. New York: D. Van Nostrand. Pp. 164. Price, 50 cents.

Herr von Förster's practical manual on the application of gun-cotton, which rests largely upon the evidence of more or less extensive experiments performed in Germany, is preceded by an account of the manufacture, properties, and uses of modern gun-cotton, by Lieutenant John P. Wisser, of the United States Army.

Synopsis of the North American Syrphidæ (Bulletin of the United States National Museum, No. 31). By Samuel W. Williston. Washington: Government Printing-Office. Pp. 335.

The family of *Syrphidæ* is one of the most extensive in the order of *Diptera*. "They contain among them many of the brightest-colored flies, and numerous specimens are sure to appear in every general collection of insects. None are injurious in their habits to man's economy, and many of them are very beneficial." To be more definite in popular description—"they are flower-flies, and feed upon honey and pollen. They are observed on blossoms of sweet-smelling, melliferous plants, such as the *Hymenoptera* prefer; and patches in bloom of blackberry (*Rubus*), wild-cherry (*Prunus*), dogwood (*Cornus*), Canada thistle (*Cirsium*), and elderberry (*Sambucus*), will always be sure to reward the patience of the collector. Some species, as those of *Syritta*, *Sphærophoria*, *Mesograpta*, etc., will be seen wherever there are blossoms. Species of the last, especially, are very abundant about corn-fields when the plants are in blossom, and will frequently alight upon one's hands; these 'sweat-flies' are feared by not a few persons, under the belief that they will 'sting.' All are sunshine-loving, and will rarely be found except in the middle of bright, unclouded days." About three hundred species are described in this volume from the region north of Mexico, in such a way that the author hopes that even the non-entomological student, with a little exertion, may be able to identify them.

The Use of Electricity in Gynecological Practice. By George J. Engelmann, M. D., St. Louis.

Dr. Engelmann believes that electricity is a valuable agent in treatment, which had, however, in his practice failed to give uniformly satisfactory results. He set himself to work to investigate the causes of the diversity in the efficiency of its application, and publishes his experiments and the results of them in the present paper. His decided success—in the treatment of pelvic disorders—in the past year, "no longer accidental, but the result of method"—has convinced him of the value of the remedy, which he is assured, when fully developed, will assume prominence. Its success and general adoption, he believes, depends upon precision and uniformity of measure and record; and he has given here, as a contribution to those factors, his own system, which includes the milli-ampère intensity of the current; size of electrodes for calculation of density; time of application, for calculation of quantity; resistance of the tissues in ohms when such resistance was unusual, or when an explanation of the intensity of the current seemed called for.

The City Government of St. Louis. By Marshall S. Snow. Baltimore: N. Murray. Pp. 40. Price, 25 cents.

This monograph is one of the Johns Hopkins "University Studies in Historical and Political Science." The "Studies" are now in their fifth series, which is especially devoted to the subjects of municipal government and economics. The history of St. Louis is given from its foundation in 1764, with the various steps of its growth as an infant settlement, a community, a municipality, and a city absorbing the county, down to the operation of the present charter, which went into effect in 1877. Mr. Snow believes that a careful study of this charter "will convince any impartial man of its great worth as a framework for a system of municipal government. The length of the term of its municipal officers; the carefully-framed provisions to secure honest registration of voters and an honest vote at the polls; the guards and checks upon all who administer the financial affairs of the city; the provisions against an undue increase of the public debt; the plan by which the important offices filled by the mayor's appointment are not vacant until the beginning of the third year of his term of office, so that as rewards of political work done during a heated campaign they are too far in the dim distance to prejudice seriously the merits of an election—these are a few of its important advantages as a plan of city government. Since its adoption it has worked well, and but few amendments have been suggested."

An Introduction to the Study of Embryology. By Alfred C. Haddon, M. A., M. R. I. A., Professor of Zoölogy in the Royal College of Science, Dublin. Illustrated. Philadelphia: P. Blakiston, Son & Co. Pp. 336. Price, $6.

This work is especially designed for medical students, and for those who have a knowledge of the main facts of comparative anatomy and systematic zoölogy. There are eight chapters, dealing with maturation and fertilization of the ovum, segmentation and gastrulation, formation of the mesoblast, general formation of the body and development of the embryonic appendages, organs derived from the epiblast, hypoblast, and mesoblast, respectively, and closing with a chapter of general considerations. Certain structures and processes which are of secondary importance, or present especially difficult problems, have been briefly mentioned or omitted. Where hypotheses have been introduced, care has been taken that the student may not mistake them for facts. Important matter has been distinguished by large type, and most of the figures have been so drawn as to admit of distinctive coloring. The classification of genera adopted is embodied in an appendix. The volume is furnished also with an analytical table of contents, an index, and a bibliography.

The Claim of Moral Insanity in its Medico-Legal Aspects. By James Hendrie Lloyd, M. D., Philadelphia. Pp. 16.

The author, who has had a large experience with cases of insanity, has not seen one case which answers to the description given in the books, of moral insanity; that is, of pure and simple dislocation of the moral nature; but all cases were accompanied with perversions of the understanding. He believes, therefore, that the conception of "the cerebrum as an individual unit, whose special act is always a reflex process of ideation, tends to a satisfactory definition and classification of insanity, as well as to an intelligible application of our knowledge to the solution of medico-legal questions much superior to anything attainable by the distinctions of the metaphysicians or the arbitrary tests of the judges."

The Fortunes of Words. Letters to a Lady. By Federico Garlanda, Ph. D. New York: A. Lovell & Co. Pp. 225. Price, $1.25.

This is a series of popular essays on English philology, which, together with much curious and useful information, conveys a vivid idea of the contrast between the modern method of scientific research in the department of language and the ways of the old etymologists. Separate chapters show how the development of industry, ethical feelings, the color-sense, and calculation may be traced in language. In another chapter the chief reasons why words change their meanings are given. The author does not utterly condemn slang, but points out that language gains some of its most vigorous expressions from the better class of slang.

Health Lessons. A Primary Book. By Jerome Walker, M. D. Illustrated. New York: D. Appleton & Co. Pp. 194. Price, 56 cents.

No child can fail to be interested and instructed by this little book. The subject-matter is embodied in simple and vivid language, and is illustrated by an abundance of original and entertaining pictures. These lessons deal almost entirely with hygiene, the author deeming it injudicious to require young children to learn much about the names and locations of bones and blood-vessels, etc. The book is divided into sixteen "lessons" of moderate length, each having at the end a short list of questions with answers. Following these is a chapter on "Accidents, Injuries, and Poisons." Some practical suggestions to teachers of health-subjects are prefixed to the volume. Special teaching as to the effects of alcoholic stimulants and of narcotics upon the human system is given in connection with the descriptions of the chief organs of the body.

Ligaments, their Nature and Morphology. By John Bland Sutton. Illustrated. Philadelphia: P. Blakiston, Son & Co. Pp. 107. Price, $1.25.

This treatise is designed to be a systematic account of ligaments and fasciæ generally, with respect to their morphology and ancestral history. Frequent reference has been made to the facts of comparative anatomy, but for the convenience of the student of human anatomy these facts have been concentrated in one chapter. The author finds that the more important ligaments "are derived either from the metamorphosis and regression of muscles, or the degeneration of osseous and cartilaginous tissues." The metamorphosis of contractile into fibrous tissue is caused by disuse and consequently diminished nutrition. In the case of many ligaments of the axial skeleton and pectoral girdle, bones corresponding to them in position have been found in certain of the lower animals, showing that these ligaments have arisen from a degeneration of osseous and cartilaginous tissues, during the development of the human species.

Chauvenet's Treatise on Elementary Geometry. Revised and abridged by W. E. Byerly, Professor of Mathematics in Harvard University. Philadelphia: J. B. Lippincott Company. Pp. 322. Price, $1.20.

Professor Byerly's edition of this standard text-book is carefully adapted to obtaining as much original work as possible from the student. He maintains that the student should be compelled to think and to reason for himself, thus gaining the power to grasp and prove any simple geometrical truth that may be set before him. "On this account, the demonstrations of the main propositions, which at first are full and complete, are gradually more and more condensed, until at last they are sometimes reduced to mere hints, by the aid of which the full proof is to be developed; and numerous additional theorems and problems are constantly given as exercises for practice in original work."

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Holmes, Mary E. The Morphology of the Carinae upon the Septa of Rugose Corals. Boston: Bradlee Whidden. Pp. 31, with Sixteen Plates.

Everhart, Professor Edgar. Infant Food and Infant Feeding. Houston, Texas. Pp. 20.

POPULAR MISCELLANY.

Recent Advances in Sanitary Science.—According to a review of the subject in "Nature," the principal fields in which advance has been recently made in sanitary science are the etiology of such diseases as Asiatic cholera, typhoid fever, diphtheria, and tubercular disorders of the lungs. The organism observed by Koch may not yet have been proved to be the actual cause of cholera; but it has been shown to be different in its mode of growth from all other organisms asserted to be identical with it, and is therefore diagnostic of the disease. In any event, the validity of the measures relied upon to prevent cholera from breaking out and spreading is not affected by the results of Koch's researches. While no micro-organism has yet been found which can be asserted to be the peculiar origin of typhoid fever, the view that that disease arises from a specific contagion, and is not propagated *de novo*, is gaining ground; and we have learned so much regarding the mode of origin and spread of the disease, that the discovery of its active cause would probably not greatly affect the measures now taken for its prevention. No results that can be exactly formulated have been obtained respecting diphtheria. It is not invariably dependent on insanitary conditions, and some facts indicate that the presence in the air of products of coal-combustion is unfavorable to it. The character of the seasons when it is most prevalent favors the theory that its specific contagium is a mold or fungus, which flourishes most strongly in a damp and smokeless air. Koch's discovery of the *Bacillus tuberculosis* as the specific contagium of tubercular disease places that malady in the class of contagious disorders. The fact that milk has been found capable of conveying disease directly or indirectly suggests the prudence of boiling it whenever suspicion of danger exists. Advances in domestic sanitation have mostly been limited to applications of principles already ascertained, especially in the drainage and water-supply of dwellings. The belief is steadily gaining ground that water once polluted by sewage can not be regarded as safe for drinking. The introduction of constant supplies of water into towns has been of great benefit. The separation of rainfall from sewage is growing in favor. The purification and utilization of sewage are receiving increased attention. The present condition of knowledge on the subject demands that sewage should, wherever it is possible, be utilized on land, as manure, in the production of crops and dairy produce; failing in this, it should be freed from its solids by precipitation, and then purified on land laid out as filter-beds. In all cases, efficient purification, not the production of crops, should be the controlling object.

Chinese in America.—Professor Stewart Culin, in the American Association, described the characteristics of the Chinese immigrants in America. They all come from the departments of Kwang Chau and Shan-King, in the province of Kwantung. They describe themselves as "Puntis," or natives, as distinguished from the tribes called "Hal-Kus," or "Shangers," who seldom emigrate, and divide themselves into the people of the Sam-Yup (three towns) and those of Sz'-Yup (four towns), from terms applied to different divisions of their native province. The people of the different districts show distinguishing peculiarities of speech and customs. Representatives of some twenty or thirty clans only are found among the immigrants. The stores are the centers around which life in the Chinese colonies revolves, furnishing supplies of Chinese wares, and serving as club-rooms and assembly-halls. Nearly all of the Chinese in America have passed some of their early years at school, where they learned to write some of the characters in their language, and to read it with more or less facility. Among the immigrants from Hoh-Shan and the districts adjacent to Canton are found many of considerable attainments—not men who would be considered scholars in China, but clerks, who are able to read and understand much of the classical literature of their country, and whose sympathies and traditions are allied with those of the literary aristocracy. This class forms a small part, however, of the whole number.

The Table-topped Hills of the Amazon.—To any one ascending the Amazon River, said Mr. James W. Wells, in the Royal Geographical Society, a most noticeable feature strikes his attention, in the table-topped hills of the Serras de Erere and Obidos, and the somewhat similar formation on the opposite bank, at the rear of the Santarem. These opposite islands form the walls of the valley through which the river, once probably a great inland lake, has excavated its way to the sea. Their summits, instead of being ridges, extend in the form of undulating savannas far inland, ever ascending, furrowed with hollows and valleys by many a stream or water-course. Strange and interesting as is the appearance of these cliffs of one thousand feet in height, yet they are not exceptional features of the basin of the Amazons; at its farther western extremity, in the Serra de Cupati, bordering on the banks of the Rio Japura, and also on the western face of the Chapada da Mangabeira, are encountered identical formations, and even to the north in Roraima and its brother Kukenam, also exists a somewhat similar appearance. These great, precipitous bluffs, and isolated table-topped hills are indicative, or at least suggestive, of a great denudation that has either long since occurred, or is yet happening. The Chapada da Mangabeira rises gradually and by regular gradients from the San Francisco River to the divide, where it appears as perpendicular walls of sandstone, with flat summits, and looks, when viewed from the east, like gigantic fortresses. The base of these cliffs is composed of a natural earth-slope of the modern *débris* of the fallen materials of the walls. Evidence is presented that this table-land extended yet farther to the west from twenty to sixty miles. The vegetation and soil of the tops of these miniature Roraimas are precisely similar to those of the great plateau, whereas the vegetation of the surrounding lowlands is quite different in character.

Some Notes about Bees.—A recently published book by Mr. Frank R. Cheshire, lecturer at South Kensington, gives some curious items of information about bees. A lens magnifying fifty times will reveal the tracheæ, and also the beautiful "salivary glands," which a skillful operator may extract through the head, after immersing the insect up to its neck in wax." There is considerable discussion among apiarists as to the uses of these glands, in which is incidentally included the question whether bees feed their young by regurgitating semi-digested food, or by a glandular system producing a nutritive secretion. Mr. Cheshire finds in the digestive system, in which "the salivary and gastric secretions perform precisely the same functions in both," . . . a most helpful similarity of physical structure between mankind and bees." Bees have, however, the great advantage over mankind of being able to carry a large stock of food and drink in their insides, and of having the power of feeding upon these stores by means of what is called the "stomach-mouth," at pleasure; or, if they choose, they can convert these provisions into building-materials. Their foot is furnished with a very sharp and powerful claw, and with a sort of soft pad that gives out a clammy secretion, by means of which they are able to walk on smooth surfaces. It is by the claws that bees hang one to another in swarming. The cutting off of a bee's head does not apparently of necessity kill it; for "drones in confinement will sometimes live very much longer without their heads than with them." The head, however, is not an unimportant part of the bee, which has a larger proportion of brain than many other insects. The poisonous property of the sting of bees lies in the formic acid it discharges, which is also "probably associated with some other toxic agent." The idea that the bee invariably dies after stinging is a vulgar error. "It will, if allowed time, generally carry its sting away by traveling round upon the wound, giving the instrument a screw-movement until it is free." More usually, however, the bee is not allowed time to travel round, "and she loses not only the sting and the venom-gland and sac, but also the lower portion of the bowel, so that her death follows in an hour or two." We are further informed that no bee inflicts a wound "until she has examined the nature of the surface to be punctured, using a pair of very beautiful organs called palpi, elaborately provided with feeling hairs and thin nerve-ends."

Mr. Edison's Pyromagnetic Dynamo.—Mr. Edison, in his paper, at the American Association, on the "Pyromagnetic Dynamo," after describing the construction and operation of the machine, said that the results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to, and probably greater than, that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. To furnish thirty sixteen-candle lights in a dwelling-house would probably require a pyromagnetic generator weighing two or three tons. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and, since there is no attendance needed to keep it running, there would seem to be already a large field of usefulness for it. Moreover, by using the regenerative principle in connection with it, great improvement may be made in its capacity, and its practical utility may very probably equal the interesting scientific principle which it embodies.

Characteristics of Tropical Woods.—Professor R. H. Thurston, describing some Nicaraguan woods in the American Association, said that the tropical and sub-tropical woods are distinguished usually by their extraordinary size, strength, hardness, and solidity, as well as by durability, as against both weather and the attacks of insects. About thirty samples, selected simply by considerations of convenience and previous acquaintance from among an enormous number of probably equally valuable genera, were subjected by the author to special tests. Some of them resembled in appearance and quality mahogany; some, our own yellow pine; others, the oaks and other hard woods of our forests, but excelled them in density, strength, elasticity, and durability. While they may prove of extraordinary value for many purposes, they are often so hard to work that their usefulness is likely to be restricted. The Central American forests contain an enormous store of timber of remarkably fine quality.

Exceptions to the Rule of Laissez-Faire.—Professor Sidgwick read an elaborate paper in the British Association on the economic exceptions to the *laissez-faire*. Political economy, he said, as commonly understood, includes a general argument showing how wealth tends to be produced most amply and economically in a society in which government confines itself to the protection of person and property and the enforcement of contracts not brought about by force or fraud, leaving individuals free to produce and transfer to others whatever utilities they choose on any terms that may be freely arranged. The argument is, briefly, that in a society so constituted, the regard for self-interest on the part of consumers will lead to the effectual demand of the things that are most useful, and the regard for self-interest on the part of producers will lead to their production at the least cost. It is, however, now generally held that the broad rule of "leave alone," to which the argument points, must in practice be limited by various exceptions. Two classes of these exceptions are distinguished, viz.: (*a*) those which are due to the limitations under which abstract economic theory has to be applied in the art of government; and (*b*) those which it is the more direct business of economic theory to analyze and systematize. In class (*a*) may be distinguished—(1) governmental interference to regulate the education or employment of children; (2) interference for the promotion of morality, health, and culture; (3) interference, not with a view to the economic production of wealth, but with a view to its more equitable distribution (this is often spoken of as "socialistic" or "semi-socialistic"); (4) interference on the ground that certain industrial classes are found by experience not to take sufficient care of their private economic interests (this is sometimes spoken of as "paternal legislation"), e. g., restrictions on freedom of contract between landlord and tenant. The same phrase is also applied to (2). As leading cases of class (*b*) may be noted—(1) where for the production of a certain utility or avoidance of detriment, a combination is required of which the value largely depends on its universality—e. g., protection of lands against floods, protection of useful animals against certain diseases; (2) especially where the combination of a large majority increases the interest which the minority have in standing aloof—e. g., abstinence from certain times, places, or instruments in fishing or hunting for the sake of future supply; (3) where a branch of industry, for technical or other reasons, has a tendency to fall under the conditions of monopoly, total or partial—e. g., provision of gas in towns; (4) where, from the nature of the required utility, its producers could not be remunerated adequately in the ordinary way by free exchange of their commodity—e. g., utility of forests in relation to climate or scientific discoveries; (5) where the process of exchange which would be required to remunerate a certain social service, would seriously detract from its utility, from waste of time or otherwise—e. g., provision of roads and bridges; (6) where government is peculiarly adapted to produce the kind of utility required—e. g., if what is required is security, as in the case of savings-banks, or uniformity, or stability of value, as in the case of currency. It is not argued that government necessarily ought to interfere in all cases that come under these headings; only that the general economic argument for *laissez-faire* falls away in such cases, wholly or to a great extent, or is balanced by strictly economic considerations on the other side; and that it is important to bear this in mind in discussing any particular practical case.

The Luminous Organs of an Insect.—Dr. Dubois has investigated the light-emitting organs of the *cucuyo*, or *Pyrophorus noctilucus*. They are three in number—two prothoracic and one ventral. The prothoracic plates give a good illumination in front, laterally, and above, and serve when the insect walks in the dark; when it flies or swims, its fine abdominal lantern is unmasked, throwing downward an intense light with much greater range. The insect seems to be guided by its own light. If the prothoracic apparatus is quenched on one side with a little black wax, the cucuyo walks in a curve, turning toward the side of the light. If both sides are quenched, it walks hesitatingly and irregularly, feeling the ground with its antennæ, and soon stops. The light gives a pretty long spectrum from the red to the first blue rays; is more green than the light of *Lampyris noctiluca*, and is capable of photography, but does not develop chlorophyl. No distinct electric action could be traced to the organs. The luminosity does not depend upon oxygen, for it is the same in pure oxygen, in air, in pressures under one atmosphere, and in compound oxygen. The organs are still brilliant when separated from the body, but the power of emission appears to depend upon a supply of water, and it is recoverable, after thorough drying, upon putting the organs again in water. Dr. Dubois found that the photogenic substance is an albuminoid, soluble in water and coagulable with heat, it entering into contact with another substance of the diastase group; part of the energy liberated appears as light.

The Drying up of Siberian Lakes.—Mr. Yadrintseff has furnished the St. Petersburg Geographical Society with evidence, consisting of notes of surveys, and maps made at four different periods, that the lakes in the Aral-Caspian depression have dried up within the last hundred years "at a speed which will surely appear astonishing to geographers." Lake Chany, the largest of the three principal lakes, has much diminished in size. Whole villages have grown on the site formerly occupied by Lake Moloki. Of Lake Abyshkan, which had a length of forty miles from north to south, and a width of seventeen miles, in the earlier years of this century, and whose surface was estimated at five hundred and thirty square miles, only three small ponds have remained. Even twenty-five years ago there were several lakes, ten and eight miles long and wide, where there are now but little ponds. The fate of Lake Abyshkan is substantially repeated in Lake Chebakly, which was represented in 1784 as an oval body forty miles long and three miles wide. Now, the largest of the three ponds which occupy its site is less than two miles wide. The same process is going on throughout the lakes of West Siberia and throughout the Aral-Caspian depression.

Electric Deposition of Dust.—Professor Tyndall observed, in 1870, that when a hot body was held in strongly-illuminated, dusty air, a dust-free space was formed above it, and this may take place even when the body is only slightly warmer than the air. Several hypothetical explanations of the phenomenon have been offered by Dr. Tyndall, Dr. Frankland, and Lord Rayleigh, but they have been inadequate to meet the requirements of the case. Professor Oliver Lodge has sought an explanation by the application of the kinetic theory of gases, and supposes that the dust-particles are kept out of contact with the warm body by means of a differential molecular bombardment of their surfaces. On the other hand, with the singular and not explained exception, that a similar dark plane, but descending, is formed below a moderately cool body, the dust-particles are driven toward, instead of away from, a cold body. This fact has been observed by Mr. Aitken, and applied by himself to the explanation of the deposition of soot in chimneys, and of lamp-black on cold glass. The result of the dust bombardment of cold bodies may also be seen in the blackening of a wall over hot-water pipes, or of a ceiling over a gas-jet. Smoking of the gas-jet will, of course, provide more material to be deposited, but the dust and smoke in the air are usually ample to effect a sufficient blackening over even a perfectly clear flame. An incandescent electric lamp, hung a foot or so under a white ceiling, will similarly cause a small, black patch. In rooms warmed by radiation, objects are warmer than the air, and keep much dust off themselves. In stove-heated rooms, things are liable to be colder than the air, and thus get exceedingly dusty. Professor Lodge supposes, also, that electrical conditions may have much to do with the matter, and relates several experiments which he has made that go to confirm this view. One of them is made with a minute, vertical water-jet, which usually scatters into drops and falls in a shower-like rain; but hold a piece of rubbed sealing-wax a yard or so distant from the place where the jet breaks, and the drops at once cease to scatter, but fall in large blobs, as in a thunder-shower. These principles are susceptible of application in many processes where dust is generated in quantities that make it a nuisance for laying it. Thus, chimney-flues may be fitted with spikes or wire nettings, which will cause the smoke to be condensed, and the dust to be deposited. So, on a larger scale, the introduction of electrical action into a cloud is supposed to give rise to rain.

Origin of Strong Liquors.—Strong liquors are a modern invention. The ancients knew of nothing more powerful than lightly fermented wines, and have left warnings enough of the abuse of them. Alcohol was not discovered till the seventh century, although an older story exists of a monk, Marcus, who collected and condensed in wool the steam of heated white-wine, and then pressed out from the wool a balsam which he applied to the wounds of those who fell at the siege of Rheims, in the reign of Clovis I. He also mixed this balsam with honey, and produced a cordial which brought the moribund back to life. Clovis, however, did not wait for the approach of death, before claiming his share of the cordial. According to Dr. Stanford Chaille, the distillation of spirits from wine was not discovered till the twelfth century, and spirits did not come into common use as drinks until the fifteenth, sixteenth, and seventeenth centuries. Professor Arnoldus de Villanova, in the fourteenth century, made a panacea of the water-of-life, which gave sweet breath, and fortified the memory, besides being good for sore eyes, the toothache, and the gout, and having other wonderful properties. Distilled spirits came into use in London in 1450, and had to be prohibited in 1494. Michael Savonarola produced a treatise on making the water-of-life in the fifteenth century, which became a standard authority on the subject, and was followed by the work of Matthioli de Sienna. These books gave the start to brandy-making in Italy, whence the trade extended to France. About 1520 the Irish usquebaugh began to acquire reputation in England. Before 1601, "brand-wine" had begun to be distilled in the Low Countries from apples, pears, and malt; and in that year an ordinance was passed at Tournay forbidding the sale of the liquor except by apothecaries, partly "because of the dearness of corn, and partly because of the drunkenness which this cheap brand-wine caused, to the great prejudice not alone of homes and lives, but to the extreme danger of the souls of its drinkers, many of whom had died without confession." The art of extracting alcohol from other substances, was gradually discovered, and liquors of various names came into use. The trade grew great, and the present century has seen a new development of it in the general application of the art of "doctoring" liquors, or adulterating.

Are there Catastrophes?—Read Mr. J. H. Kerry-Nichols's account of one only of the many things that took place in New Zealand on a June day only about a year ago: "The most remarkable feature in the same line of volcanic action was the extraordinary convulsion which had changed the whole conformation of the country around Rotomahana, and had transformed the hot, green lake with its marvelous terraces into a roaring crater, from which rose a column of steam nearly a mile and a quarter in diameter, that ascended in the form of a cumulus cloud to a height of thirteen thousand feet, and nearly a mile in width. Thus in the brief space of four hours this delightful fairy-land was transformed into a condition suggestive of a scene in Dante's 'Inferno.' The spot where the white terrace formerly stood had been occupied by a crater, forming a kind of horseshoe bay, and from this a column of steam rose and mingled with the general mass. The site of the Pink Terrace, once on the western shore of the lake, now stood a quarter of a mile from the margin of the present crater, in the midst of a mass of boiling mud black and brown in color, with seething pools of steaming water or liquid mud, which was sometimes cast up into fumaroles, ejecting steam and vomiting forth stones and mud, with a noise like the roar of innumerable steam-engines."

Persian Astrologers.—The *monajem*, or astrologer, is a power in Persia. He is recognized as a man of science, a member of a learned profession. The chief astrologer is a high court official, from whose ruling there is no appeal, for his decisions are based upon knowledge that is communicated directly from the stars. Thus, if he decrees that the Asylum of the Universe must not start on a hunting expedition on Thursday, but that half an hour after midnight on Saturday will be the fortunate hour, he is able to give irrefragable reasons for his conclusions by showing that Saturn is in the ascendant in the one case, while on Saturday night, at the precise time mentioned, there will be a happy conjunction of Venus. If another astrologer is consulted, he will give the same story. Every hour in the day, and every day in the year, is thus worked out as fortunate, indifferent, or unlucky in the astrologer's Books of Fate. Besides these calendars, they have as their stock in trade a plumb-line, a level, a celestial sphere, and an astrolabe. The astrolabes are in the form of a gigantic watch, and are often beautifully made. Every large town contains at least two astrologers, and they are very far from being poor. A Persian may find an astrologer very useful, especially if he be an officer, and desire to evade some responsibility. Thus, suppose a provincial governor is ordered to the capital, and that he does not want to go, what more powerful reason for delay in starting than to reply that he is waiting for a fortunate hour, and what easier than to induce the astrologer to fail to find one? In the mean time, the officer has time to administer the necessary bribes at court, and the storm blows over. *Istikhara*, tossing up, or the drawing of the lot, is done with a rosary. A bead is grasped at hap-hazard, "Good," "Bad," "Indifferent," is ejaculated at each bead, till the big terminal one is reached, and that decides the question. Answers are given in conversation, bargains are made or refused, and serious acts are undertaken under the guidance of this formula. Another way is to thrust a knife into the leaves of the Koran or one of the poetical books, and be guided by what is found at the place. The diviners are real quacks, and gain their success by working on the fears of the people. The guilty party in a scandal or criminal inquiry in his nervousness is provoked to do some act that brings about his detection.

The Nature of Diatoms.—The curiously beautiful microscopic objects called diatoms can be found in the mud at the bottom of all pools of water. They were formerly regarded as animals, but are now classed among plants. Professor W. Mattieu Williams discovered their vegetable character thirty years ago by an observation which amounted to a demonstration. The white quartz pebbles in his aquarium became coated with a brown growth, caused by the development of these organisms, and at the same time evolved bubbles of gas. In the course of a few days he found an inch of the vertical space of the test-tube which he fixed to catch it filled with this gas, and it was proved by burning wood and other experiments to be nearly all oxygen. Animals expire carbonic acid, plants expire oxygen. Therefore the diatoms were plants.

A Rock-sculptured City.—Montpellier-le Vieux is the name given to a curious city-like group of weather-sculptured rocks, which M. E. A. Martel has described to the French Academy of Sciences. It is near Millau, in Auvergne, France, and about twenty-five hundred feet above the sea. It is composed of a mass of isolated rocks, averaging perhaps about two hundred feet in height, so similar to embattled towers that one group has been called the Citadel; around this mass are five depressions three or four hundred feet deep, of which one resembles an amphitheatre, a second a necropolis, a third a parade-ground, and another a regularly laid out city quarter with public monuments, gates, straight streets and intersections suggesting at once such places as Pompeii, Carnac, and Persepolis. The whole, occupying about five hundred acres, is surrounded by a rocky formation having the aspect of a wall three or four hundred feet high. The ravines under the bases of these walls might be regarded as fosses, and the scattered groups of rocks in the neighborhood as the fortifications of outer lines of defense.

Idiosyncrasies of Plants.—An English reviewer of a book by Mr. Charles Roberts, called "The Naturalist's Diary," mentions the idiosyncrasies of certain plants and animals as a feature to which more attention might be given. Thus, a quantity of seed taken from the same plant at the same time, and sown under the same conditions so far as possible, will nevertheless exhibit very great variation in the length of time required for germination. The fact enforces the circumstance that the same amount of aggregate temperature and of water-supply, the same conditions of soil, etc., do not necessarily imply corresponding identity of result. The same thing happens in trees. Every one knows how some individual horse-chestnut trees are year by year more precocious in their development than their fellows. It sometimes happens, too, that one branch of one tree is considerably in advance of the others. Some persons might call these cases exceptions, but they are hardly that. Since they are connected with the main body of habitudes by every possible gradation, they are to be considered as extremes rather than as exceptions, and therefore to be included in the making up of averages.

NOTES.

President Peckham, of the Natural History Society of Wisconsin, has been investigating the mental habits and peculiarities of wasps. On the question whether these insects have much sympathy with one another, he says: "To be sure, when we caught numbers of them, and painted them within the cage, they at once went to work to clean each other, and this shows that they have some desire to aid and comfort their friends. But we have often seen them continue to eat, with entire composure, near the body of one of their number that had just been crushed to death; and they frequently fall upon a dead relative, cut it up, and carry it into the nest to feed their young."

Mr. H. Stuart Wortley, of the South Kensing on Museum, has been led, by long and careful attention given to the observation of animals, to consider that they have true reasoning powers, and says on this subject: "I have frequently seen reasoning power exercised after obvious thought over the best course to pursue. Then, *are* animals speechless among themselves? I think not, and believe they speak freely to one another at needed times, in their own language. And I certainly with my own domestic animals can understand in a certain sense their language. I clearly know what they ask for, or what they wish to call my attention to, from the tone of the voice and its modulations, and this is, I assume, language as regards them."

Professor Helmholtz has been appointed President of the *Kuratorium* of the Physical and Technical Imperial Institution which is to be opened at Berlin in 1888. Dr. Werner Siemens, the founder of the Institution, and Dr. Förster, the Director of the Berlin Observatory, will also be curators.

According to Mr. John Ball's "Notes of a Naturalist in South America," the various ports along the arid coast of Peru, destitute of verdure, reveal upon close examination the presence of plant-life. At Coquimbo veritable bushes and a greenish-gray tint on the surface of the soil were visible, and specimens were obtained of some curious and rare plants in flower peculiar to the vicinity, among them a dwarf cactus only three or four inches in height, with comparatively large crimson flowers.

An appearance as of being hollowed out has been remarked in the surface of the hard, green sandstone rocks, near Lima, Peru, and was ascribed by Sir Charles Lyell to the result of water-action on ancient and subsequently elevated sea-beaches. Mr. Nation, of Lima, however, who has been observing the rocks for twenty-five years, is satisfied that the hollows are increasing in size and in number. He believes that they are the work of a cryptogamic plant, a lichen, which is in active vegetation during the foggy season, the swelling of whose cells causes a scaling of the rock.

A new telephonic apparatus, called the "Micro-telephone Push-button," has been successfully experimented with in Paris. It has the form of an ordinary electric push-button, and is so sensitive that in speaking at short distances there is no need to come close to the instrument. Persons using it may speak in their ordinary tone, walk about, and act as if they were conversing with some person in the room. The paragraph from which we derive this item intimates that the perfection of the instrument is due to the inventor having resided in America, where his inventive talent was stimulated.

Mr. Clement Reed, of Oneglia, believes that the destructive effects of the earthquake in the Riviera may have been more owing to the method of building than to the violence of the shocks. The walls of the houses at Oneglia and at Diano Marina are built of rounded stones or rubble, filled in with stucco, and the floors with brick arches, without sufficient care being given to lateral support; and the houses are usually three or four stories high. It is evident that even a slight shaking would be fatal to buildings thus constructed.

Mr. Chamberlain, in his monograph on the Ainos, asserts, on the authority of the Rev. Mr. Batcheler, who has lived among that people for many years, that intermarriages between them and the Japanese are not fruitful, and conduce to weakly offspring and a short-lived stock. There seems, therefore, to be a kind of reproductive incompatibility between the two races. The occupation of the northern islands by the Japanese in place of the Ainos, who are diminishing, or of a half-breed race which is not found, may be accounted for by the unfruitfulness of the half-breeds, and by the superior vigor of the Japanese race to the Ainos.

Mrs. Hardwicke, widow of the founder of "Science Gossip," preserves eggs fresh by carefully oiling them with a soft brush all over, and packing them in a jar with plenty of bran between each layer. A thick brown paper should be tied over the jar when it is full. "When eaten at three months old," she says, "you could not tell them from fresh eggs."

The announcement is provocative of thought that the invitation which the Government of New South Wales gave last year to the British Association to meet in Sydney in January, 1888, has had to be withdrawn, because the matter had been made a party question in the New South Wales Parliament. The fact illustrates anew the truth that science and current politics will not mix.

According to the observations of M. Cazeneuve, the aniline dyes—fuchsine, Bordeaux red, red, purple-red, etc.—employed in coloring wines, may persist for many years in certain wines, and be obtained intact therefrom by analysis. The chemical changes that wine undergoes, especially in the "stripping" of new wines, lead to the precipitation of a greater or less amount of the artificial coloring agent. The diseases produced by microphytes also cause a disappearance of color.

"Since the introduction of the water-closet, and, I believe, as a direct consequence of it," said Dr. G. V. Poore, at the anniversary meeting of the Sanitary Institute of Great Britain, "we have had four severe epidemics of cholera (a disease not previously known), and enteric or typhoid fever (previously almost or quite unrecognized) has risen to the place of first importance among fevers in this country (England). The evils which have arisen from cesspools and sewers have caused an enormous amount of attention to be devoted to what are known as 'sanitary appliances,' 'sewer constructions,' etc., and so great and so well recognized are the evils of sewers that many of our friends are anxious that we should be compelled by act of Parliament to protect ourselves from the mischief which previous acts of Parliament have produced."

The preliminary steps have been taken for the organization of an Australasian Association for the Advancement of Science on the same lines as the British Association. The first and inaugural meeting is to be held in Sydney in 1888, which will be the centennial year of the foundation of the colony of New South Wales. The Royal Society of New South Wales, already in operation, is pursuing a system of offering medals and money prizes for original researches on scientific subjects, particularly for investigations relating to Australia. Four prizes are offered every year, consisting of the society's medal and £25, to be awarded for as many researches of superior merit.

A grass resembling the Canadian "sweet grass," but of finer texture and fragrance has been discovered growing at Ocean Beach, New Jersey, and is utilized by a family of Indians there for making fancy baskets. It is identified by Dr. Samuel Lockwood with the *Hierochloa borealis*, or "holy grass" of Europe, and as probably the same colony which Dr. Knieskern announced several years ago that he had discovered near Squan Village. As the name "holy" or "sacred" grass would be without significance in this country, and the fragrance of the plant is like that of vanilla, Dr. Lockwood suggests that it be called "vanilla-grass."

Dr. J. W. Stickler, in the "Report of the New Jersey State Board of Health," finds that persons who work in hat-factories are subject to lung-complaints arising from the inhalation of fur-dust. Silk-weaving in dwelling-houses is deleterious, but ought to be a healthy occupation in properly lighted, heated, and ventilated factories. The hackling of flax and jute fills the air with a dust of dirt and minute fibers, leading to paroxysms of coughing, and often to early death; and the spinning process is attended with similar evils. According to Dr. J. P. Davis, the disorders arising from India-rubber manufacturing are chiefly due to the lead-compounds used in the work, accompanied with heat and defective ventilation, to the introduction of naphtha, and to mechanical conditions.

Biscuits appear to have been the most ancient form of bread. It is not known how early fermentation was introduced, but it appears certain that cakes made simply of flour and water preceded it. Such cakes, of the Neolithic age, are found in the lake-beds of Switzerland—and these are the oldest surviving specimens of bread. Most of the ancient peoples used biscuits on special occasions, as of war and long voyages. The Greeks called them *arton dipuron*, or bread exposed twice to the fire. The Romans had their *panis nauticus* or *capta*. Our word *biscuit—bis*, twice, and *coctus*, French *cuit*, cooked, twice cooked, the same in meaning as the Greek name, is a survival from the original method of preparing the cakes, which is no longer in use.

Professor Emil Du Bois-Reymond, the twentieth anniversary of whose appointment as Secretary of the Academy of Sciences of Berlin is celebrated this year, has had the privilege of introducing a succession of famous representatives of science in speeches which gave proof of his great ability as an author. He is one of the oldest members of the physico-mathematical class of the Academy; the only member of older standing being Chevreul, whose patent antedates his seventeen years.

The city of Nancy, in France, on the 21st of July, suffered the strange visitation of a rain of wood-ants. It was about five o'clock in the afternoon when the "shower" came up, and the insects, both winged and unwinged, fell upon the streets and public places, and on the heads of passers-by, like a snow-squall, for about an hour. Most of the town was literally covered with ants. They are supposed to have been taken up somewhere and brought to the place by the strong gusts which preceded a severe storm that fell upon the city during the night.

Professor Tyndall expressed a doubt, in his last Royal Institution lecture, as to whether extensive reading and study had not a tendency to hamper original genius; whether doctrines handed down for generations as articles of faith, which it would be heresy to dispute, had not materially checked the progress of science.

Pilocarpine is an alkaloid obtained from the leaves of *Pilocarpus primatus*. It is a viscous substance, giving finely-crystallized salts, and has been applied to various therapeutic uses.

JOHN JACOB BAEYER.

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INVENTIONS AT PANAMA.

By STUART F. WELD.

AS the difficulties connected with the Panama enterprise, from at least certain points of view, increase, its advocates dwell even more than hitherto upon the way in which like difficulties were overcome at Suez. Probably no more pointed or liberal recognition of these has appeared than one contained in a speech of Mr. Gladstone in the House of Commons, July 23, 1883. Speaking for the ministry, he said:

"We think it our duty to do justice, as far as lies in our power, to this great canal company, and to its sagacious and energetic projectors.. I say that they have claims upon us—claims to respect and honor; for they have conferred a vast benefit upon mankind, and have conferred it by enormous labors, and in the midst of great dangers, under unparalleled difficulties—difficulties which were, unhappily, in some respects due to the unfortunate action of this country in former times."

It is not to be inferred, however, that if such obstacles were successfully overcome, a similar success is to attend the efforts at Panama. Should some sanguine advocate of the enterprise aver that the stockholders were to be as richly rewarded as those of Suez, and within as short a time, we should listen to the prediction with no every-day skepticism, and should insist upon drawing our own conclusions. Many would as readily accept the wonders of the Arabian Nights as trust to estimates of this description. It will not answer to carry too far a similarity, though its existence is not to be denied, between the completed undertaking and the one De Lesseps has now in hand.

But if, from a financial point of view especially, the prospects of the undertaking are not as bright as its advocates might desire, it is apparent that the company is aware of the difficulties ahead, and is taking what steps under the circumstances are possible. Important announcements were made at the last annual meeting, July 21st. To reduce the ultimate cost, significant changes, De Lesseps stated, had been determined upon. The immense dam, as to which so much controversy has existed, is suppressed. The tide-lock, which was to have been built at the Pacific terminus, is eliminated; also the basin, five kilometres long, at the center of the Isthmus. Nor is the intimation lacking that the dimensions of the channel itself may be reduced. When the president of the company observes that after his inspection of the work, to occur in a few months, he will finally be able to state how the completion of the undertaking is to be effected, one can not but ask whether, to furnish as expeditiously as possible a provisional, serviceable channel, the plan of a lock-canal may not be adopted. Such a solution is not wholly improbable. Subsequently, if the prospects of the enterprise allow, for the above solution the original plan may be substituted; the channel may be cut to the sea-level. The adoption of a lock plan, the summit level to be fed by the Chagres, has been for months, and is still, under consideration by the engineering authorities.

By means of whatever instrumentalities, whether of an engineering or non-engineering type, the company is to proceed with the work, and whatever doubt attaches to the choice of these, none seems admissible as to completion itself. This can hardly be considered a question. Such a view is confirmed by the recent inspection of the work by Lieutenant Charles C. Rogers, U. S. Navy, a brief reference to whose views occurs in an addendum to the present article. While much interest attaches to aspects of the case, which have been referred to—instrumentalities to be employed and the decisions of scientific authorities—there is a question which has not received the attention it deserves, and which is intimately connected with the financial outcome. This it is proposed to examine. How far has the faculty of contrivance and that of invention accelerated the work? How far may it be expected to in future? Such an aspect of the case deserves more attention than many suppose.

The hostility of England to the Suez Canal placed that enterprise for a time in a critical position, by bringing about the abolition of forced labor. But this opposition was in fact the best aid that could have been furnished the undertaking, for it led to the invention of machines which shortened and cheapened the work to a remarkable degree. These inventions have been of service in similar enterprises ever since. Had less efficient devices been brought out at Suez, De Lesseps might well have hesitated before entering upon the more difficult task at Panama. But to meet these more serious obstacles, he possessed mechanical appliances far superior to the rude enginery of 1854. And if, as it is reasonable to anticipate, further radical improvements in machines for this kind of work are made, the financial prospects of the Panama Company will not by any such instrumentality suffer.

Inventions are one of the factors of the case. If the French can prove themselves as expert in surmounting difficulties as they were twenty years ago, the confidence with which they still apply themselves to their task will possess a stouter foundation.

The Hon. John Bigelow, in his report to the New York Chamber of Commerce, after his inspection of the work in February, 1886, expresses the opinion that it is upon this factor (inventions) that De Lesseps relies in his anticipations of early success. He adds that De Lesseps's "own remarkable experience"—referring to Suez—has taught him to look with some confidence in this direction. The question of the ultimate success of the French company might possibly hinge upon such a condition.

The French Academy of Sciences, in a report on the Panama enterprise, dated August, 1880, says, "Every great undertaking, properly conducted, brings about improvements in the processes of execution." *

It may not be entirely safe, even in the case of an enterprise running through ten or twelve progressive years, to count on great and radical improvements in the machinery used. On the other hand, such improvements have helped to solve some of the greatest mechanical problems of the century. Such are the Mont Cenis and St. Gothard Tunnels, and the Suez Canal. Will the Panama scheme receive a corresponding help? It is not to be denied that it has already received assistance of this sort. We proprose to consider the question of inventions, as regards each of the engineering works referred to, with reference especially to what has been done and is to be done at Panama.

We will consider, first of all, the tunnels; next, the canals.

Work upon the Mont Cenis Tunnel was begun in 1857, about two years before De Lesseps commenced operations in Egypt. The working parties in the opposite headings, French and Italian, met on Christmas-day, 1870, about a year after the inauguration of the Suez Canal. The St. Gothard Tunnel was begun after the completion of the Mont Cenis, in 1872; the headings met February 29, 1880. The length of the Mont Cenis Tunnel is over seven and a half miles; that of the St. Gothard about nine and a quarter miles. These are the longest tunnels ever constructed.

The invention, by means of which the progress of the work was facilitated, consists in the use of atmospheric air as a motor. By means of water-power, air is reduced to one sixth its ordinary bulk, and the expansive force thus acquired performs the drilling. Owing to the conditions under which tunneling is done, this method is of signal advantage. Each of the Alpine tunnels was excavated through solid

* "Bulletin du Canal Interocéanique," August 15, 1880.

rock, so that blasting was necessary. The use of explosives vitiated the air, while the length of the passage and the impossibility of sinking shafts made the ventilation question a vital one. Had the drills been run by steam, the presence of steam-engines constantly generating smoke and gas would have heated and vitiated the air still further. By the new invention the difficulty was met. The air was compressed outside the tunnel, and conveyed into it by pipes. Here a double purpose was served: by its expansion and liberation the air ran the drills, and ventilated the tunnel. The invention which makes this practicable is called the Sommeiller machine, from the name of the chief inventor.

In an address delivered before the American Geographical Society in December, 1879, Major S. F. Shelbourne referred to the manner in which the work in the Alpine tunnels was accelerated by inventions. The subject of the address was the San Blas route for an interoceanic canal. To construct a canal at this point, it would be necessary to cut a ship-tunnel seven miles long; and it was the purpose of Major Shelbourne to show that the advances made in the mechanical arts during the building of the Alpine tunnels, made a ship-tunnel much more practicable than was supposed. It may be added that, at the time referred to (1879), three competent American authorities—Major Shelbourne, Walton W. Evans, and Frederick M. Kelley—advocated the San Blas route. Of all the routes proposed, it was the shortest, the distance being thirty-three miles from sea to sea, against forty-six at Panama. After the work had been begun at Panama, however, Mr. Kelley, whose interest in the subject was so great that he spent out of his private fortune $120,000 for surveys upon the Isthmus, became an advocate of that undertaking.

Major Shelbourne said:

> In 1863 the progress made in the Mont Cenis Tunnel with hand-drilling, and powder as an explosive, was an average of a foot and a half a day. After they had commenced to introduce power-drilling and the Sommeiller machine, the progress they made was three times greater—that is, four and a half feet per day.

Major Shelbourne next adduced the testimony of Mr. Shanly, the contractor of the Hoosac Tunnel, after observing that in 1872 the Hoosac Tunnel was "in the rush of its progress" under him. Mr. Shanly stated, in 1874: "The use of the machine-drills saved about two thirds of the expense of drilling. The expense of labor would have been, I think, fully three times the cost of machine-drilling." Major Shelbourne next cited the progress effected at St. Gothard, the contract for which was taken in 1872 by Louis Favre, of Geneva:

> In the St. Gothard Tunnel, from 1875 to 1877, with the greater perfection of explosives—for they had come to use nitro-glycerine—and by means of improved drills,* they made a progress of five to one, that is to say, they excavated

* An account of the drills used in the St. Gothard Tunnel may be found in Simms's "Tunneling," pp. 305-320.

their tunnel about five times as fast as was the progress in the Mont Cenis Tunnel in 1863 by hand-drilling. Now, in the years 1878 and 1879, by the general improvement of the whole administration in the St. Gothard Tunnel, they are making a progress of more than eight to one, or about thirteen feet per day, through granitic gneiss in a single heading. So that now, if they can excavate and remove rock from a tunnel eight times faster than they could fifteen years ago, you may readily see how much easier, how much more feasible, a tunnel has become to-day on an isthmus-canal route than at the time, in 1870, when the surveys of Selfridge were made. Indeed, these naval officers in their sphere of action were ignorant of and had not conceived as possible these strides of inventive and engineering skill.*

A few weeks after the address of Major Shelbourne, a paper was read before the American Society of Civil Engineers by Walton W. Evans, in which he described the augmented power of the Sommeiller machine during the excavation of St. Gothard. He said:

"I was shown at the St. Gothard Tunnel steam-drills that by slow motion and high pressures would walk into granite as a knife would into cheese; there was nothing used on the Mont Cenis Tunnel to approach them in efficiency. I was shown air-compressors that kept their great reservoirs, night and day, under pressures of 110 pounds to the square inch, and without difficulty; it was with difficulty and uncertainty that the air-compressors of the Mont Cenis Tunnel could keep the pressure up to 60 pounds to the square inch." He adds: "We are clearly a progressive race, and it would be a wise brain that could predict with certainty what advance may be made by some live Yankee in tunneling machinery when we come to cut a ship-tunnel." †

Mr. Evans was, we may remember, like Major Shelbourne, in favor of the San Blas route, and the tunnel which that route involves.

Certain details as to the machinery used in the Alps may be of interest. After hand-drilling was given up, all the drills used were run by compressed air, but the methods employed to compress it varied. At Mont Cenis hydraulic power exclusively was used. Sommeiller employed at first the fall of a column of water in the same way in which it is applied in the case of the water-ram. Afterward he substituted turbine-wheels. To compress the air at the St. Gothard, ordinary steam-power was at first used.‡ Afterward the improved method of Sommeiller, the turbine-wheel, was substituted. It was found that the amount of water available at the southern terminus was not as large as at the northern; in the former case, accordingly, a higher fall of water was required. A useful or effective fall, as it is

* "Journal of the American Geographical Society for 1879," p. 240. In the exhaustive report upon the canal problem submitted to the Navy Department in 1883 by Lieutenant J. T. Sullivan, extracts occur from the address of Major Shelbourne. He is our best authority as to the San Blas route.

† "Transactions of the American Society of Civil Engineers," 1880, p. 15.

‡ Hence, perhaps, the somewhat ambiguous expression used by Mr. Evans, "steam-drills," though it is possible that "steam" is a misprint for "steel." (?)

called, of 279 feet, was sufficient at the northern end, while at the southern a fall of 531 feet was employed.

The air-compressor used at the St. Gothard had been improved to such an extent by Professor Colladon, of Geneva, that it is often called the Colladon compressor. One of the devices employed was this: The compression of air rapidly generates heat, and to reduce the temperature of the compressing cylinder a circulation of water was kept up all around it. The piston and piston-rod were hollow, and water was introduced into them in like manner. In the shape, finally, of fine spray, water was injected into the cylinder, and thus brought into contact with the air itself.

Not a little interest attaches to circumstances connected with the invention of Sommeiller. This engineer had two associates, Grandis and Grattoni. All were Italians, and all worked together in the evolution of the problem. No statement has appeared designating the part, or significance of the part, taken by each—a fact somewhat to their credit. Of the three, Sommeiller, however, came to be the best known; a member of the Sardinian Parliament, he appeared in public, as his associates did not. His name suggests a French, or, at least, Savoyard origin, but the inventor was a Piedmontese, and in his writings used the Italian tongue.

The St. Gothard Tunnel is by some considered the most remarkable engineering work extant.* Mr. W. W. Evans, already quoted, writing in 1879—and whatever he says upon this point refers to his fixed idea that the proper route for an interoceanic canal was San Blas—says:

> Our weak-kneed people, who get frightened at the idea of a tunnel, should go to Europe, and study tunneling as done there. I found over two hundred tunnels between Nice and Spezzia on the edge of the Mediterranean, cut and used for a very limited railway travel. The line of the St. Gothard Railway is a perfect marvel for tunnels. Nearly one fourth of the whole line is in tunnels. The great or summit tunnel is nine and a half miles long; and in seven places on the line—three on the Swiss side of the St. Gothard, and four on the Italian side—they have tunneled into the sides of the mountain in great entire circles of a thousand metres diameter, merely to get distance and keep the line to their fixed maximum gradient of one in forty, or say one hundred and thirty-two feet to the mile. And what is all this terrible expenditure for? Why, merely to rehabilitate the trade which the Suez Canal has opened, and which the people of the Mediterranean enjoyed, and out of which they built their great cities.†

Whether or not we consider the connection as immediate between Suez and St. Gothard, as our author does, it is to be admitted that the introduction of new processes in the case of these tunnels and consequent acceleration of the work naturally encouraged those, like Mr. Evans and Major Shelbourne, intent upon the cutting of a tunnel for ships. Nor would the larger dimensions of such a work necessarily

* Appletons' "Annual Cyclopædia," 1881, p. 819.

† "Journal of the American Geographical Society for 1879," p. 115.

establish its impracticability. The advocates of San Blas counted upon further advances in the tunneling art, just as De Lesseps has counted upon and witnessed like advances in the art of constructing and operating the excavator and the dredge.

We have considered the way in which inventions expedited the cutting of the two greatest engineering works, probably, ever built to promote communication by land; the two greatest to promote communication by water remain to be considered. The Alpine invention, the air-pressure engine, was not used upon the Suez Canal, nor has it been at Panama. The special kinds of work to which it is adapted are tunneling and mining. There could be no question of a tunnel at Suez. On the other hand, in the plan for a sea-level canal at Panama submitted to the Paris Congress, two solutions were presented. The Cordilleras were to be pierced either by a tunnel or open cut. Tunnels of four or five different lengths were proposed, and calculations submitted; but the congress came to no decision on this point. Had the tunnel plan been adopted, the tunnel would have been excavated by the Alpine method, but subsequently the open-cut plan was adopted, and hand or steam drills instead of air-pressure drills have been employed. Nitro-glycerine, however, which had been substituted for powder during the work at St. Gothard, is largely used.

In considering the two canal enterprises of De Lesseps, we begin with the one completed. As has been said, when, through the intervention of the British and Turkish Governments, the Suez Company had to abandon forced labor, not a little injury was inflicted upon the work. The damage was obviated in part by the indemnity paid by the Egyptian Government, thirty-eight million francs, and in part by the inventions of French engineers. In fact, the company proved to be the gainer. The immense dredges which took such an active part in the rest of the work were contrivances of this period. As to the power and capacity of these machines, we can hardly do better than quote the British historian of the canal, Percy Fitzgerald.* After observing, vol. i, page 202, that the chief contractors, Borel and Lavalley ("men of extraordinary energy and fertility of resource"), came to the task under every disadvantage, and had to establish their workshops and machinery in the desert, he continues:

"They saw at once that the new difficulties as to procuring labor and the limited time allowed by the contract could only be overcome by the aid of machinery of the most daring and novel kind. They accordingly devised those extraordinary dredges which have been the admiration of engineers. . . . No one," he adds, "who has seen an ordinary dredge at its slow work in an English river could have an idea of the bold fashion in which the principle was now applied."

And he thus refers to the general capacity of foreign engineers:

* "The Great Canal at Suez. Its Political, Engineering, and Financial History." 2 vols. By Percy Fitzgerald, London, 1876.

These inventions show the admirable fertility of resource that regulates the work of foreign engineers, who devise machinery to suit the difficulties of each stupendous work; whereas in this country (England) the objection is often made to such undertakings, that engineering does not furnish means to accomplish them. However this may be, the Mont Cenis Tunnel and Suez Canal are excellent instances in point, the difficulties themselves prompting the discovery of means to overcome them.

For a detailed description of the Suez dredges and their appurtenances, Mr. Fitzgerald's work may be consulted, vol. i, pages 203–212. Here we shall only give an account of the principles involved and certain particulars, in which these mechanisms were in advance of preceding ones. The great dredges and excavators employed at Panama go back for their origin to this period. In 1860 an invention was brought out by two engineers, Cavé and Claparède, to facilitate the excavation of canals and cuttings upon railroads. They proposed to use a series of scoops or buckets attached to a revolving, endless chain, and to apply this device both to the ordinary dredge, and to a machine, constructed for the purpose, to be used in dry excavation. This was the origin of the present chain-of-buckets dredge and chain-of-buckets excavator.* The latter machine was first used in France in 1860 upon the Ardennes Railroad, between Sedan and Thionville. In an article in "Le Génie Industriel" for December, 1860, containing cuts of the chain-dredge and chain-excavator, it is said: "Such machines may, above all, be applied to the work on the Suez Canal. They will allow of the reduction in a notable manner of hand-labor, and, in consequence, economize a considerable part of the expense."

This statement was written about eighteen months after work on the Suez Canal was begun; just what the writer anticipated occurred. By one of the contractors, Lavalley, the principle of Claparède was successfully applied to dredges; and the Claparède excavator was in like manner improved by another of the contractors, Couvreux, who built what is called the *excavateur Couvreux*. He took a contract for excavating the seuil d'El Guisr, a ridge which crosses the line of the canal for a space of ten miles, its highest points being sixty-five feet above the sea. This work was finished six months inside the contract time, a result to be ascribed in part to the Couvreux excavator.

One of the improvements introduced by Couvreux consisted in inserting movable bottoms in the buckets. In clayey and adhesive soils the buckets sometimes clogged, so that much time was required to clear them. By the new arrangement the bottom was forced forward, and the clearance thus effected. The bucket having descended, a fresh load of earth drove the bottom into its original place. An article in "La Propagation Industrielle" for September 1, 1868, illus

* This principle, it is true (the use of the endless chain), was applied to a certain extent in the case of dredging, both in France and England, early in the century. (See Knight's "American Mechanical Dictionary," vol. i pp. 717, 718.)

trated by cuts, describes this contrivance, and also another of the improvements of Couvreux. These applied, by-the-way, to the buckets and chains of dredges as well as to those of excavators.

Professor J. E. Nourse, U. S. Navy, in his report on the Suez Canal, published in 1884, says (p. 69) with reference to the French excavator:

> In 1865 Couvreux invented a dry dredger which he called the *excavateur chargeur.* This was a dredger mounted on a car which ran on a tramway parallel with the canal. Its chains and iron buckets descended to scoop up the sand, emptying it into cars, which were themselves drawn up to the summit of the embankment along a succession of tramways.

In the above extract the method is designated by which the earth scooped up by the excavator is got rid of—that is, by means of dirt-cars on common tracks. The methods by which the earth brought up by dredges was disposed of were three in number: By the first the sand was emptied into a hopper and thence conveyed through a duct, two hundred and twenty feet long, to and beyond the banks. Steam-pumps injected water into the hopper, thus facilitating the discharge. Such a dredge was called a *drague à long couloir.* At times the banks were too high to admit of this process, and recourse was had to the second method, a mechanism called the *élévateur.* It consisted of an elevated railroad, supported by iron posts, partly upon the bank and partly upon a barge between the bank and dredge. Sometimes the dirt-cars carried the earth to a height of fifty-six feet. The cars were attached to an endless chain, and passing upward along the road were emptied, and returned underneath the track. Cuts of these parts of the machinery may be found in Professor Nourse's report already referred to. The third method was the common one of barges or lighters. These were furnished with engines, and carried their contents either to lakes along the line of the canal, or near either terminus, to the sea, and were emptied by means of under- or side-doors.

While, in executing an undertaking like that at Suez, the work consists chiefly in digging, certain parts require to be built up in the proper sense of the term. It was necessary to establish upon the Mediterranean an artificial harbor, and two jetties were constructed. Here was founded the city of Port Said. In the construction of these piers we have an example of the way in which the adversaries of the undertaking asserted, without any sufficient basis, the impracticability of the work. The "Edinburgh Review," referring to the construction of the jetties, said: "Any constructions attempted so as to form an entrance for the canal will be swallowed up. Every block, every stone, will be swallowed up, and we shall not see a single one above water." Mr. Fitzgerald quotes this passage. Referring in particular to the western pier, supposed to be specially difficult of construction, because it was to arrest large bodies of sand moving at this point of the coast from west to east, he says it had been again and again pronounced impossible to build it, because stone was not to be obtained. There were no quarries, it was alleged, nearer than Lake Timsah or Suez, and quarry-stones could not be dragged one hundred or even fifty miles across the desert. It turned out that there were quarries near Alexandria, whence the stone might have been brought by sea. The contractors, however, as the historian of the canal tells us, "fell back on their own resources"; they manufactured the stone on the spot. The artificial blocks thus compounded were two thirds sand and one third hydraulic lime. Each weighed over twenty tons, and nearly thirty thousand were manufactured and tumbled into the sea. We are assured that "the whole has continued as firm as any structure of the kind in Europe, and is consolidating with every year."

The not carefully considered prediction of the "Edinburgh Review" is almost without significance when compared with others made in the House of Commons by Robert Stephenson and Lord Palmerston. If not the first, Mr. Stephenson was one of the first, of English engineers. In a debate, in June, 1858, Lord Palmerston referred to the scheme as "the greatest bubble that had ever been sought to be imposed on the credulity of the public." The canal, Mr. Stephenson averred, was "physically impossible." It was a mistake to talk of a canal. "It would be simply a ditch. . . . How could a canal be dug eighty miles long, without drinking-water along its course?" But the project, supposed to be so impracticable, did not deserve this sort of treatment. Within thirteen years of inauguration it paid seventeen per cent. That such predictions were falsified, and in so signal, even grotesque a fashion, was due, in part at least, to the inventive capacity, the constructive talent, which the undertaking called forth. Upon Lavalley and Couvreux, as well as upon De Lesseps, it devolved to show that ditches might be made serviceable, and a financial "bubble" converted into an astonishing success.

The part of our subject now examined serves, strictly speaking, as an introduction to what in a special sense we have to consider—the work at Panama and connection of inventions with it. Of the three enterprises to which attention has been directed, one—that at Suez—bears a close analogy, both as to the use for which it was built and the character of the machinery employed, to the enterprise at Panama. Such an analogy we do not meet, if we set alongside the case of the tunnels and that of the American enterprise, although from one point of view the work in them resembled more closely that at Panama than that at Suez. In the case of the tunnels, blasting was the regular process, hardly a foot was excavated without it; and a very considerable amount of blasting is required at Panama. Visitors to the works have in fact compared the explosions heard for miles along the excavation to musketry-discharges in battle. In respect to the use of explosives, then, an analogy exists between the Alpine and Panama undertakings. The introduction of nitro-glycerine proved in both cases of great advantage. At Suez, on the other hand, the occurrence of rock was rare, and blasting was resorted to only in exceptional cases.

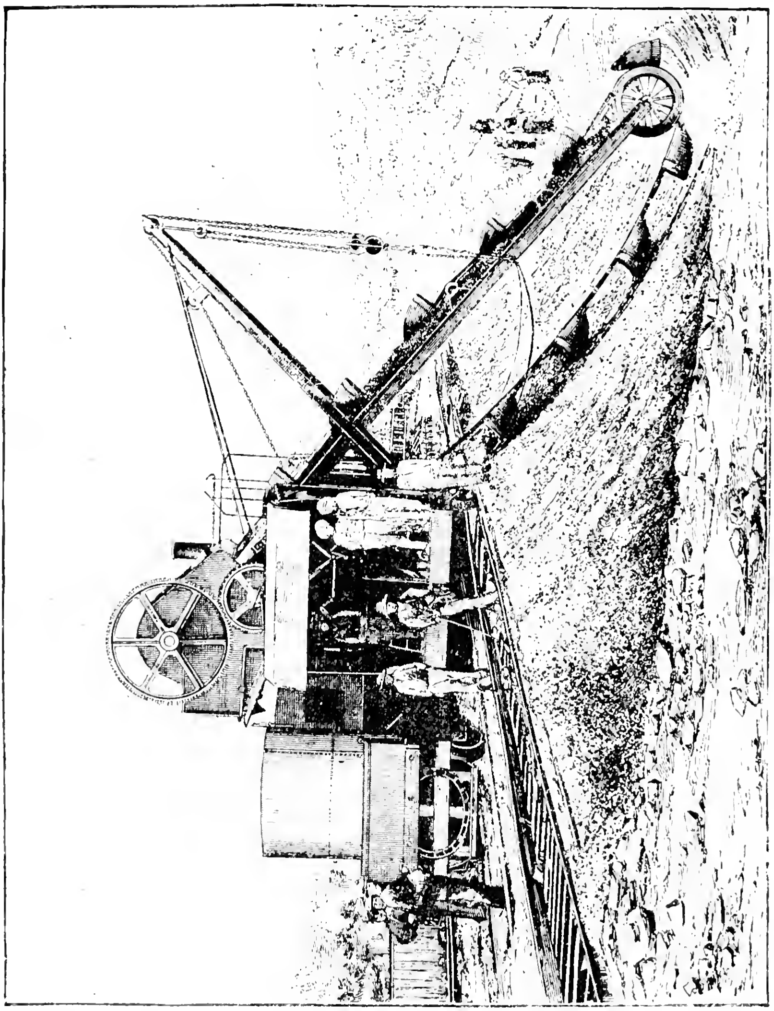
While from such points of view analogies may be apportioned among the enterprises—two railroad and two ship-canal enterprises—which occupy us, it may not be denied that the work at Panama and machinery used for it bear a special resemblance to those at Suez. Nor may we lose sight of the fact that from an extra-scientific point of view, one individuality, one firm resolve, have, rather than other human agencies, accomplished in each case whatever has been done. As regards the enterprise first carried through, we have considered some of the advances made in the engineering and mechanic arts. To say that these have contributed to the feasibility of the work at Panama is to say but little. They alone, perhaps, have rendered it possible. But for them, the Paris Congress might not have been held; the Panama work might not have been even begun, still less in process of execution.

We come, finally, to the question of inventions in immediate connection with Panama. These seem to consist, thus far, chiefly in an increase in the size and power of the machines, whether dredges or excavators, employed. But ingenuity may at any time supply any need that develops itself, and it has effected part of what has been done already. An opinion formulated by the French Academy of Sciences in 1880, regarding inventions in connection with such work, has been quoted. Lieutenant N. B. Wyse, of the French Navy, whose plan for a sea-level canal was adopted by the Paris Congress, has also touched upon this point. He refers to objections urged against a sea-level canal. The plan involved either a huge tunnel or a huge open cut; in either case the work would be much in excess of any of a like character hitherto attempted. He says, "The course of events, experience based upon precise observation, will undoubtedly suggest new processes, or processes scarcely caught sight of at the present day, so as to conquer the difficulties indicated."*

Such anticipations have not been entertained without cause. The major part of the excavation has not yet been done, but already the

* "Rapports sur les Études de la Commission Internationale d'Exploration de l'Isthme Américain, par Lucien N. B. Wyse," p. 56. Whatever the services of Lieutenant Wyse in the surveys of the Isthmus, between 1876 and 1879, it should be remarked that his work, published last year, "Le Canal de Panama," is not to be read without allowances. The rupture which occurred between himself and De Lesseps in 1880, due to the fact that Wyse, as he himself tells us, expected to be appointed director-general of the work, and was not so appointed, has led to acrid criticisms on his part upon the company. That part of his work which relates to his surveys—the larger part—possesses not a little interest, and is not perhaps open to much criticism; but, as regards his strictures upon the company, the fact referred to is to be kept in mind.

mechanisms used have been brought to a state of efficiency—one could not say perfection—never reached in the case of any other undertaking. In attempting to trace how this has been brought about, we may begin with one of the first of the new processes introduced, the American method of boring to test the strata and use of the diamond-drill. In



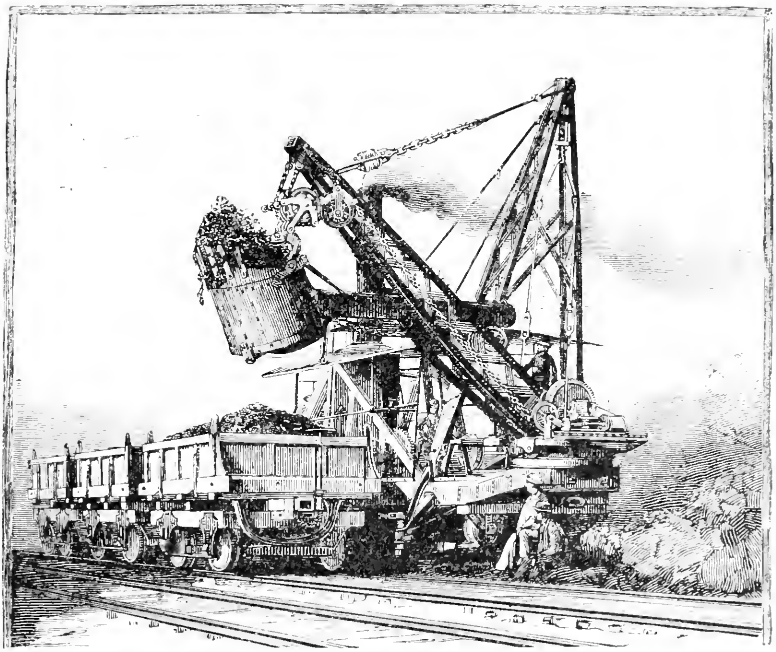
French Excavator (from Lieutenant Kimball's Government Report).

September, 1883, the director-general of the works, Dingler, gave an address in Paris upon the then condition of the enterprise, in which he says:

For the great cutting we have made a large number of American soundings. The Americans in this special matter have made considerable progress, and have rendered us very great service.

Ordinarily, when soundings are made, the yield is brought up in a pulverized state, so that the engineer is obliged to make many conjectures as to the quality of the rock, in order to know what slope to give the excavation.

Generally one is much puzzled. The Americans have discovered a method of bringing up the rock itself in a shape large enough to admit of our judging as to its hardness. A *carrot*, as the workmen call it, is fetched up. It is obtained by means of a cylinder armed at its lower extremity with black diamonds. This is given a rapid rotary motion; it descends and penetrates into the rock, and in this way we can bring up a block which furnishes the exact consistency of the strata. We placed, before the eyes of the commission,* this morning, a box of specimens taken in Culebra. The result is, that we have a perfect knowledge of the ground, and it is these soundings which enable us to fix our prices.



AMERICAN EXCAVATOR (reduced from cut in "Scientific American")

The following reference to these American soundings occurs in Admiral G. H. Cooper's report to our Government on the progress of the work, dated March 2, 1883. After observing that soundings to ascertain the nature of the soil had been made all along the line, he says:

The first of these soundings were made by French engineers, with the old-fashioned drill and spoon to bring up specimens. This method took many months and was very unsatisfactory; and, finally, the contract for making the remaining soundings was given to Mr. George R. Burt, an American, who is connected with the Panama Railroad Company. Mr. Burt has used the American diamond-drill, and with it has accomplished more work in the past three months than had been done by the other method in the previous two years.

* The "Commission consultative" of engineers.

The connection is so close between the consistency of the strata and the slope of the cutting, that the following as to this point will be of interest. The director-general continued:

Well, these borings, made in large numbers at Culebra, showed us that we had to excavate a rock, semi-hard, schistous in quality, having nearly horizontal strata, and that the earth was dry. The result is, that one could not desire better earth for a work of such an exceptional character. We shall be obliged, manifestly, to be very prudent. Accordingly, at the top we have opened the cutting, as if the slope was to be a gentle one. We remove the clayey part which, under the action of water, can be brought to the consistency of paste or mud. Here we have made a very ample opening. But in proportion as we reach clear rock, we make the prism narrower, so as to comprise the cubic contents strictly necessary, with the purpose to make the slope more gradual should experience require it.

The bringing together by an undertaking such as Panama of contractors of divers nationalities, naturally leads to the use of various machines, and it remains to be seen what advantage is to be derived from the sort of rivalry thus established. Here the Panama work may be said to possess an advantage over Suez. The latter was almost exclusively in the hands of French engineers, and was carried through by French contractors and inventors. A single Englishman, Ayton, contracted for a considerable part of the work, but he became bankrupt owing to the withdrawal of forced labor, and the French were obliged to assume his portion.* In the case of Panama, contractors of several nationalties have been employed—French, English, Dutch, Swedes, Swiss, Italians, Americans, and Colombians. The "Canal Bulletin" for February 15, 1885, contains a table of contracts, arranged according to nationality, entered into at the time.

After treating of the American use of the diamond-drill, the director-general proceeded to speak of some of the other machines employed.† He said:

The excavation is effected in different ways. We are very *eclectic* at Panama. We reject no system, no method, and as the earth varies at every step, as the works at one point do not resemble those at another, we can try different ways. At certain places we have mellow earth, which is generally composed, in the valleys, of clay mixed with a feldspathic sand. In such places we can make the attack by mechanical processes. We employ excavators.

There are two sorts of excavators, the French and American. The American excavators are very ingenious, and in mellow soil they give satisfactory results. The French excavators are of a type already tested in many places. In clayey and rather adhesive earth they seem preferable. Accordingly, the American papers, knowing, not that we had declared as much, but that facts had

* Fitzgerald's "Suez Canal," vol. i, p. 200.

† The diamond-drill has recently been put at Panama to a use other than prospecting. The apparatus of the American Diamond-Drill Company is employed to blast rocks under water. Dynamite is the explosive used, and the rock is so thoroughly shattered that a dredge readily removes it. (See "Canal Bulletin," January 15, 1887.)

demonstrated this superiority, engaged in a little controversy in which patriotism was mixed up. Finally, I wrote to the American contractors that I had never come to any prejudiced decision, that I was wholly disposed to make use of their skill, which I acknowledged to be incontestable, and of their great experience in public works.*

The essential difference between the French and American excavator is as follows: The French, as has been said, carries a series of buckets attached to an endless chain. The American—with which Americans are comparatively familiar—has a single bucket; it is larger than the French buckets, and is worked at the end of a lever. The French buckets, though smaller, revolve rapidly; their number and constant motion compensate perhaps for their size. Cuts of each system are annexed. It may be remarked as to French excavators, that sometimes the buckets ascend filled with earth *below the bucket-ladder*, as in the cut, and sometimes, the motion of the chain and position of the buckets being reversed, *above it.* The cut of the French excavator is a reduced cut of an illustration in Lieutenant Kimball's government report. That of the American excavator, also that of the American dredge, found farther on, are reduced from illustrations which appeared in "The Scientific American" in 1884 and 1886. The principle of the French excavator is applied with differences of detail in several ways. There are, or have been recently, at work at Panama the following French or Belgian excavators—named respectively after the manufacturer or designer, Ville-Châtel, Evrard, Weyer et Richemond, Gabert, Boulot, Demange, and Andriessen. There were of the American excavator two types, the Osgood and Otis.

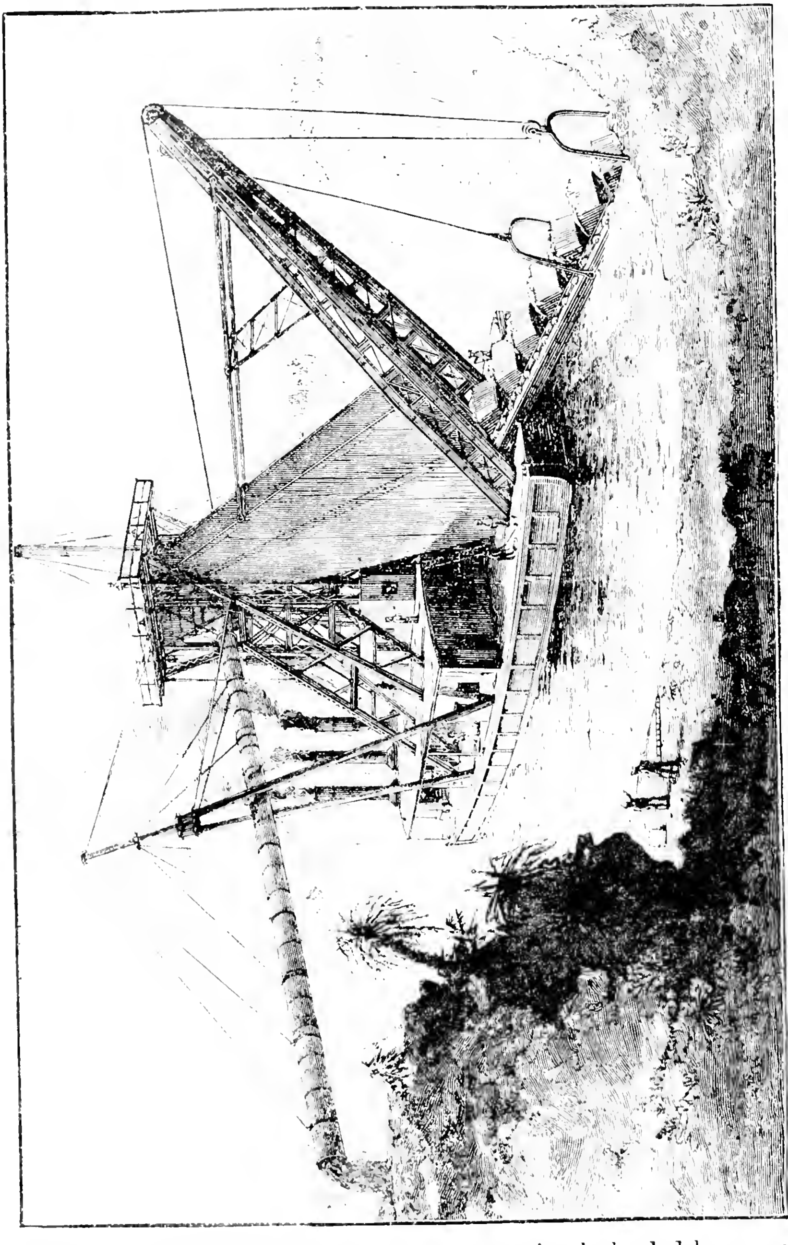
The director-general, after this reference to excavators, observed that in rocky parts excavators could not be used.

In rock excavation a method has recently been tried of breaking up masses of rock by powder and dynamite combined. An explosion of this kind was witnessed by De Lesseps and the party which accompanied him in February, 1886. In a subsequent communication to the French Academy of Sciences,† he gave an account of the wreck of a mass of porphyry amounting to thirty thousand cubic metres, on this occasion. The charge consisted of two parts dynamite to one of powder. Some idea of the force of the explosion may be derived from the pains taken to block the passage which led to the charged chamber. For the space of thirty feet it was packed with masonry. Upon a public occasion soon after, De Lesseps held up a fragment of the rock dislocated, observing that here was one-billionth part of it!

* Lieutenant W. W. Kimball, United States Navy, in his report to our Government, after his inspection of the canal in January, 1886, claims that the American excavator excels in stony soil and surface soil with roots, while the French machine is better in light soils and sand. The officer of our navy who inspected the works last March, Lieutenant C. C Rogers, who has been referred to elsewhere, confirms this.

† "Bulletin du Canal Interocéanique," May 1, 1886.

The advantage of using powder and dynamite combined is thus explained. If dynamite alone were used, the breakage would be carried



AMERICAN DREDGE (reduced from cut in "Scientific American").

too far; the fragments could not be as conveniently loaded by cranes. The effect of powder would be to project the fragments too far, thus damaging, it might be, the neighboring works. As regards the use of dynamite, we might query whether, if a still stronger explosive were employed, the rock might not be reduced to pebbles or sand. In this state it might be handled by the buckets of excavators, and the slower operation of cranes be avoided. We might speculate further, whether the explosives said to have been recently invented in France and Germany, or like substances, might not be of service. If, as is understood, the governments which possess them desire to keep the process of manufacture secret, some difficulty might be experienced in procuring them. But civilization might be the gainer if such inventions were used to blast a thoroughfare at Panama instead of to enhance the rapidity with which human slaughter is carried on.*

Of all writers who have interested themselves in the Panama Canal no one has given the amount of attention to inventions bestowed by Mr. Bigelow in his report to the New York Chamber of Commerce. We can not do better than give his views upon this topic. These, again, may serve to introduce further particulars as to the machinery employed. After observing that the wages of unskilled labor when work was begun were ninety cents a day, and have since advanced to a minimum of $1.75, and that even at this price the company does not readily get the labor needed,† he says:

The question then arises, Must the work be prosecuted under the present conditions?

"When the Jews were required to make brick without straw, Moses came. May not the exigency, like child-bearing, work its own cure?

In all ages and nations, when manual labor has become too costly to do the work for which there was a universal or even a general need, a substitute for it has been promptly devised. It was to the need of economizing muscular labor that we owe the hoe, the wheelbarrow, and the plow. Had laborers' wages never risen above a shilling a day, we should never have heard of McCormick's reaper, or of Howe's and Singer's sewing-machines. It is equally certain that the portion of our planet which lies under the tropics will never play the part in human history to which its territorial extent and productive power entitle it, until our present assortment of mechanical substitutes for muscular power has been very largely increased. Machines do not mind malaria: they are not poisoned by marshy water; they thrive on the black-vomit; they have no fear of chills or sunstrokes; and, what is more, they are never tired, and will work all the days and nights of their natural lives without interruption, if properly fed and cared for.

That is the class of operatives for out-of-door work in the tropics, and it is to them that M. de Lesseps must, and I presume does, look for an early completion of his canal; for it is in that direction his own remarkable experience

* No secret seems to attach to the composition of a new explosive, bellite, to which an article is devoted in the "Scientific American," May 14, 1887. This explosive, it is stated, has been found more effective in quarries than any nitro-glycerine compound.

† One of the chief difficulties of the company at present is getting an adequate labor-supply. In the "Canal Bulletin," June 16, 1887, the fact is noticed that at several points part of the machinery provided was lying idle, owing to this lack. Several hundred Chinese had arrived but recently, and it was hoped that their labor would prove as effective as that of the Chinese employed upon the Panama Railroad forty years since.

has certainly taught him to look with some confidence. When the work on the Suez Canal was begun, and under climatic conditions much the same as those at the Isthmus of Panama, the Suez Canal Company was entitled by its charter to as many native laborers as it required up to forty thousand, and at an almost nominal price. As these men were drafted into the company's service by *corvée*, England protested against a "revival of slavery" in Egypt. The Khedive was constrained to break his contract with the company, for which he had afterward to pay an indemnity of thirty-eight million francs, and M. de Lesseps had the mortification of seeing his little army of twenty thousand fellahs dispersed as suddenly and as irrevocably as an April fog.

The logic of the situation promptly suggested the replacing of the men with machines; the putting of slaves without souls or sensibilities in the place of slaves with both. The inventive genius of his countrymen was stimulated by the gravity of the crisis, and in due time from eighty to one hundred dredges, with an appropriate supply of barges, elevators, steam-tugs, locomotives, etc., had taken the place of a large portion of the men withdrawn; and this machinery, with only four thousand men, increased the monthly output from ten thousand cubic metres to two million, and executed more excavation in the last three years of the work than had been done in the previous seven. May not the scarcity and cost of manual labor on the Isthmus in like manner develop the means of dispensing with at least that portion which the labor market will not cheerfully supply?

The results already accomplished in that direction justify the expectation that, to a considerable extent, it may. There are already at work on the Isthmus machines for dredging and for excavation, far more powerful and efficient than any ever used on the Suez Canal or anywhere else.

It is the opinion of Mr. Bigelow that De Lesseps's "remarkable experience" at Suez has led him to anticipate the forwarding of the Panama work by similar means. This expectation is illustrated by an incident of the Paris Congress. Lavalley, the inventor of the dredges, was there—was in fact a member; and to him De Lesseps referred at one of the sittings as an engineer "who had already invented so many machines, and who, under similar circumstances, would know how to invent more."

Mr. Bigelow observes, with regard more especially to excavators, "There is no reason to suppose that, in the creation of such machines, art and science have reached a limit in any direction." One might say with Arago:

> "Croire tout inventé n'est qu'une erreur profonde;
> C'est prendre l'horizon pour les bornes du monde."

We can not suppose that an horizon of inventive impossibilities has settled down about Panama.

With regard to Mr. Bigelow's statement that there are at work machines for dredging and excavation "far more powerful" than any ever used elsewhere, it has been already stated that the greater power of these mechanisms is chiefly due to their increased dimensions and the higher steam-power employed. Let us take the "City of New

York," the greatest dredge probably ever constructed; built by the American Contracting and Dredging Company, and by them used at Panama. The engines of the largest Suez dredges had a force of seventy-five horse-power. Those of the "City of New York" have a force of three hundred. To run all parts of the complicated machinery, no fewer than eight are employed. The huge ladder which carries the buckets is one hundred and ten feet long; the chain to which the buckets are immediately attached, if ruptured, would reach from the top to the bottom of Bunker Hill Monument. Two discharge-pipes, each three feet in diameter and one hundred and eighty feet long, carry the earth to the banks. By means of steam-pumps, as in the case of the Suez dredges, water is forced into the bell or hopper, and the discharge facilitated. The effectiveness of this mechanism is not due solely to its construction on an enlarged scale; contrivance comes in for part of the credit, and has effected part of the result. One of the peculiarities of the American dredges may be referred to. To steady the vessel and hold the buckets against the bank, two spuds or pile-anchors are employed. In the case of the "City of New York" these spuds are sixty feet high and two feet in diameter. They pass through the hull, one on each side, and the iron chisel-point at the termination of each weighs eighteen hundred pounds. This is planted in the bottom. When spud No. 1 descends, it serves as a pivot around which the dredge, carrying the bucket-ladder in operation, slowly revolves, thus traversing the arc of a circle. When No. 1 is raised, No. 2 is lowered, and serves in like manner as a center. After this fashion, planting a foot at a time, this huge digging, spouting creature, as one might term it, advances. The movement through an arc is regulated by two distance-lines, so called. These are attached to windlasses, one on each side of the forward deck, the other end being attached to the shore. As one line is drawn in, the other is paid out, and by this simultaneous process the motion in curves is maintained.* A high degree of interest attaches to a structure combining power, ingenuity, and complexity as these are not united in any other mechanism of the sort. Such among contrivances of the kind is the "City of New York."

With regard to the amount of excavation effected by the dredgers of the American Company, Mr. Bigelow sets it down as about double the largest output of any machine at Suez. Lieutenant Kimball, comparing the output of the later American dredges with the best at Suez, sets it down as more than double, twelve hundred cubic metres per hour, as compared with four hundred and eighty.

While in the matter of dredges Americans have contributed of late more than others by fresh devices and an increase of dimensions, the French seem to have effected like results with regard to excavators.

* For these particulars as to the working of the spuds, etc., the writer is indebted to Lieutenant W. W. Kimball, U. S. Navy.

Those first employed at Panama had a force of twenty-four horse-power, while the powerful machines more recently sent out have a force of ninety. The French have lately employed in connection with their excavators a mechanism similar to the *élévateur*, already described. It is called the *transporteur*, and consists of an elevated structure which performs the same service for an excavator that the *élévateur* does for a dredge. The earth is deposited from the buckets upon an endless belt. This passes round two drums about two hundred feet apart, and in the interval rests upon friction-rollers. The earth is thus carried outward from the excavation, and at the same time upward.

While, owing to the power and size of her digging mechanisms, the Panama undertaking has quite an advantage over Suez, it is not to be assumed that this advantage may not be further increased. Upon this contingency the decision of important questions may depend. Whether the canal be finished, at least provisionally, as a lock-canal or cut immediately to the sea-level, is possibly one of these. But the decision as to locks will have to be expeditiously arrived at; and if inventors are to step in and affect in any sort of way the result, they have not much time for contrivance and experiment. At all events, we may hope much from the fact that the undertaking is probably in the best hands to which it could have been intrusted. Owing to the completion of former contracts, or the substitution of later for earlier ones, the greater part of the work devolves at present upon French or American contractors. The portion undertaken by the American company consists, it is true, wholly of dredging—the easiest part of the work. There can be no doubt as to the satisfactory, and, should it prove necessary, rapid completion of this part of the undertaking; the chief difficulty lies in the excavation of dry earth and rock, and this is chiefly in the hands of the French.* But American inventions and skill may be as serviceable here as in any other section of the work. It is a pledge of earnest effort that the two republics which have the work in charge have also a greater stake than others in the completion of the undertaking—France, because French capital has furnished the funds; America, because of our need of a

* According to the plans of the company, as described recently by Charles de Lesseps, Vice-President of the Suez and Panama Companies, part of the work which it was thought must be done by excavators may be effected by dredging. With this end in view, he tells us, the company is making preparations. It is proposed to introduce into the works, between Gamboa and Paraiso, the waters of the upper Chagres. An analogous plan served the same purpose at Suez: fresh water was introduced from the Nile; nine dredges were carried up by a lock and floated upon it. These operated upon a temporary lake, whose level was seventeen feet above the Mediterranean. Whether such a plan, by some thought impracticable, may be successfully applied at Panama, remains to be seen.

For a description of the manner in which the Nile water was employed, see Fitzgerald, vol. i, pp. 190–191.

shorter water-way between our Atlantic and Pacific coasts. And certainly no other nations offer greater achievements in inventions and execution as a guarantee of success.

Nothing, perhaps, so strongly characterizes this century as the advance man is making in exploring, understanding, and obtaining a mastery over Nature. This process of mastery could scarcely proceed in a more instructive way than by tracing its stages in the instances we have considered. The Alps and the two Isthmuses illustrate it in a not unfitting way. It is safe, probably, to say that the power to excavate earth, to excavate and blast rock, is from five to ten times as great as when a man, wholly unknown to fame, landed with a handful of his countrymen where the city of Port Said now stands and began the excavation of Suez.

In regard to the present enterprise upon the American Isthmus, if we take into account its magnitude and the difficulties involved, it represents without doubt the greatest effort in the line of industry and peaceful achievement man has yet put forth. De Molinari, the Belgian economist, computed that the stock of machinery for the excavation represented the labor of half a million men. Such a fact indicates how far the process of conquering Nature has been carried. The world is watching, with no doubt a degree of skepticism, the way in which the remaining work is being done; and in scientific circles especially an eager interest will continue to be manifested in this great struggle of skill and inventive genius against the forces and obstinacy of Nature. It may be protracted, but it must be in the end successful.

Addenda.—In the article in "The Popular Science Monthly" for July, entitled "The Panama Canal," a statement occurs, page 329, with reference to a report to the Navy Department by Lieutenant C. C. Rogers upon the state of the work in March. This statement is not in all respects correct. The foot-note in which it occurs was based upon a dispatch from Washington, not seen by the writer until after the proof-sheets had been returned. Subsequently a rectified statement was obtained from Lieutenant Rogers. As the views of the latter are soon to be given to the public in full—not a few await them with interest—and probably in advance of the publication of the present article, no special importance attaches to a correct statement here of his positions. The writer quotes, however, with the permission of Lieutenant Rogers, the following from a letter in which he defines his views. The passage quoted refers, not to the chances of the completion of the canal (for its completion Lieutenant Rogers thinks more than probable), but to the chances of its completion by the present company. As regards the dispatch already referred to, he says: "The reporter has called largely upon his imagination in saying that I doubt whether the French company will be able to complete the canal. If the new loan be wisely spent, and a good showing results, their chances for so doing will be good; for the necessity of finishing the work will be apparent." Respecting statements frequently set afloat as to alleged mismanagement, and likewise the company's chances of success, he adds: "One who thinks that the officers do not realize the question in its true aspect, who regards the engineers as inefficient, and the whole company as blind, is in great error. If they do as well in the next eighteen months as during the past year, their chances of completing the canal will be more than good."

SCIENCE AND PRACTICAL LIFE.*

By Professor T. H. HUXLEY.

THE middle of the eighteenth century is illustrated by a host of great names in science—English, French, German, and Italian—especially in the fields of chemistry, geology, and biology; but this deepening and broadening of natural knowledge produced next to no immediate practical benefits. Even if, at this time, Francis Bacon could have returned to the scene of his greatness and of his littleness, he must have regarded the philosophic world which praised and disregarded his precepts with great disfavor. If ghosts are consistent, he would have said: "These people are all wasting their time, just as Gilbert and Kepler and Galileo and my worthy physician Harvey did in my day. Where are the fruits of the restoration of science which I promised? This accumulation of bare knowledge is all very well, but *cui bono?* Not one of these people is doing what I told him specially to do, and seeking that secret of the cause of forms which will enable men to deal, at will, with matter, and superinduce new natures upon the old foundations."

But, a little later, that growth of knowledge beyond imaginable utilitarian ends, which is the condition precedent of its practical utility, began to produce some effect upon practical life; and the operation of that part of Nature we call human upon the rest began to create, not "new natures," in Bacon's sense, but a new Nature, the existence of which is dependent upon men's efforts, which is subservient to their wants, and which would disappear if man's shaping and guiding hand were withdrawn. Every mechanical artifice, every chemically pure substance employed in manufacture, every abnormally fertile race of plants, or rapidly growing and fattening breed of animals, is a part of the new Nature created by science. Without it, the most densely populated regions of modern Europe and America must retain their primitive, sparsely inhabited, agricultural or pastoral condition; it is the foundation of our wealth and the condition of our safety from submergence by another flood of barbarous hordes; it is the bond which unites into a solid political whole, regions larger than any empire of antiquity; it secures us from the recurrence of the pestilences and famines of former times; it is the source of endless comforts and conveniences, which are not mere luxuries, but conduce to physical and moral well-being. During the last fifty years, this new birth of time, this new Nature begotten by science upon fact, has pressed itself daily and hourly upon our attention, and has worked miracles which have modified the whole fashion of our lives.

* From "The Advance of Science in the Last Half-Century." New York: D. Appleton & Co. 1887.

What wonder, then, if these astonishing fruits of the tree of knowledge are too often regarded by both friends and enemies as the be-all and end-all of science? What wonder if some eulogize, and others revile, the new philosophy for its utilitarian ends and its merely material triumphs?

In truth, the new philosophy deserves neither the praise of its eulogists nor the blame of its slanderers. As I have pointed out, its disciples were guided by no search after practical fruits, during the great period of its growth, and it reached adolescence without being stimulated by any rewards of that nature. The bare enumeration of the names of the men who were the great lights of science in the latter part of the eighteenth and the first decade of the nineteenth century, of Herschel, of Laplace, of Young, of Fresnel, of Oersted, of Cavendish, of Lavoisier, of Davy, of Lamarck, of Cuvier, of Jussieu, of De Candolle, of Werner, and of Hutton, suffices to indicate the strength of physical science in the age immediately preceding that of which I have to treat. But of which of these great men can it be said that their labors were directed to practical ends? I do not call to mind even an invention of practical utility which we owe to any of them, except the safety-lamp of Davy. Werner certainly paid attention to mining, and I have not forgotten James Watt. But, though some of the most important of the improvements by which Watt converted the steam-engine, invented long before his time, into the obedient slave of man, were suggested and guided by his acquaintance with scientific principles, his skill as a practical mechanician, and the efficiency of Bolton's workmen, had quite as much to do with the realization of his projects.

In fact, the history of physical science teaches (and we can not too carefully take the lesson to heart) that the practical advantages, attainable through its agency, never have been, and never will be, sufficiently attractive to men inspired by the inborn genius of the interpreter of Nature, to give them courage to undergo the toils and make the sacrifices which that calling requires from its votaries. That which stirs their pulses is the love of knowledge and the joy of the discovery of the causes of things sung by the old poets—the supreme delight of extending the realm of law and order ever further toward the unattainable goals of the infinitely great and the infinitely small, between which our little race of life is run. In the course of this work, the physical philosopher, sometimes intentionally, much more often unintentionally, lights upon something which proves to be of practical value. Great is the rejoicing of those who are benefited thereby; and, for the moment, science is the Diana of all the craftsmen. But, even while the cries of jubilation resound and this flotsam and jetsam of the tide of investigation is being turned into the wages of workmen and the wealth of capitalists, the crest of the wave of scientific investigation is far away on its course over the illimitable ocean of the unknown.

Far be it from me to depreciate the value of the gifts of science to practical life, or to cast a doubt upon the propriety of the course of action of those who follow science in the hope of finding wealth alongside truth, or even wealth alone. Such a profession is as respectable as any other. And quite as little do I desire to ignore the fact that, if industry owes a heavy debt to science, it has largely repaid the loan by the important aid which it has, in its turn, rendered to the advancement of science. In considering the causes which hindered the progress of physical knowledge in the schools of Athens and of Alexandria, it has often struck me* that where the Greeks did wonders was in just those branches of science, such as geometry, astronomy, and anatomy, which are susceptible of very considerable development without any, or any but the simplest, appliances. It is a curious speculation to think what would have become of modern physical science if glass and alcohol had not been easily obtainable; and if the gradual perfection of mechanical skill for industrial ends had not enabled investigators to obtain, at comparatively little cost, microscopes, telescopes, and all the exquisitely delicate apparatus for determining weight and measure, and for estimating the lapse of time with exactness, which they now command. If science has rendered the colossal development of modern industry possible, beyond a doubt industry has done no less for modern physics and chemistry, and for a great deal of modern biology. And as the captains of industry have, at last, begun to be aware that the condition of success in that warfare, under the forms of peace, which is known as industrial competition, lies in the discipline of the troops and the use of arms of precision, just as much as it does in the warfare which is called war, their demand for that discipline, which is technical education, is reacting upon science in a manner which will, assuredly, stimulate its future growth to an incalculable extent. It has become obvious that the interests of science and of industry are identical; that science can not make a step forward without, sooner or later, opening up new channels for industry; and, on the other hand, that every advance of industry facilitates those experimental investigations upon which the growth of science depends. We may hope that, at last, the weary misunderstanding between the practical men who professed to despise science, and the high-and-dry philosophers who professed to despise practical results, is at an end.

Nevertheless, that which is true of the infancy of physical science in the Greek world, that which is true of its adolescence in the seventeenth and eighteenth centuries, remains true of its riper age in these latter days of the nineteenth century. The great steps in its progress have been made, are made, and will be made, by men who seek

* There are excellent remarks to the same effect in Zeller's "Philosophie der Griechen," Theil. II, Abth. ii, p. 407, and in Eucken's "Die Methode der Aristotelischen, Forschung," pp. 138, *et seq.*

knowledge simply because they crave for it. They have their weaknesses, their follies, their vanities, and their rivalries, like the rest of the world; but whatever by-ends may mar their dignity and impede their usefulness, this chief end redeems them.* Nothing great in science has ever been done by men, whatever their powers, in whom the divine afflatus of the truth-seeker was wanting. Men of moderate capacity have done great things because it animated them; and men of great natural gifts have failed, absolutely or relatively, because they lacked this one thing needful.

To any one who knows the business of investigation practically, Bacon's notion of establishing a company of investigators to work for "fruits," as if the pursuit of knowledge were a kind of mining operation and only required well-directed picks and shovels, seems very strange.† In science, as in art, and, as I believe, in every other sphere of human activity, there may be wisdom in a multitude of counselors, but it is only in one or two of them. And, in scientific inquiry, at any rate, it is to that one or two that we must look for light and guidance. Newton said that he made his discoveries by "intending" his mind on the subject; no doubt truly. But to equal his success one must have the mind which he "intended." Forty lesser men might have intended their minds till they cracked, without any like result. It would be idle either to affirm or to deny that the last half-century has produced men of science of the caliber of Newton. It is sufficient that it can show a few capacities of the first rank, competent not only to deal profitably with the inheritance bequeathed by their scientific forefathers, but to pass on to their successors physical truths of a higher order than any yet reached by the human race. And if they have succeeded as Newton succeeded, it is because they have sought truth as he sought it, with no other object than the finding it.

* Fresnel, after a brilliant career of discovery in some of the most difficult regions of physico-mathematical science, died at thirty-nine years of age. The following passage of a letter from him to Young (written in November, 1824), quoted by Whewell, so aptly illustrates the spirit which animates the scientific inquirer that I may cite it:

"For a long time that sensibility, or that vanity, which people call love of glory, is much blunted in me. I labor much less to catch the suffrages of the public than to obtain an inward approval which has always been the mental reward of my efforts. Without doubt I have often wanted the spur of vanity to excite me to pursue my researches in moments of disgust and discouragement. But all the compliments which I have received from MM. Arago, De Laplace, or Biot, never gave me so much pleasure as the discovery of a theoretical truth or the confirmation of a calculation by experiment."

† "Mémorable exemple de l'impuissance des recherches collectives appliquées à la découverte des vérités nouvelles!" says one of the most distinguished of living French *savants*, of the corporate chemical work of the old Académie des Sciences. (See Berthelot, "Science et Philosophie," p. 201.)

CHANGES IN THE RELATIVE VALUES OF THE PRECIOUS METALS.

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ECONOMIC DISTURBANCE SERIES, No. VI.

THE ECONOMIC DISTURBANCES RESULTING FROM RECENT CHANGES IN THE RELATIVE VALUES OF THE PRECIOUS METALS.—Notwithstanding the great attention that has been given to this subject in recent years—with its almost interminable resulting publications and public and private discussions—there is probably no other one economic or fiscal problem concerning which there is so little comprehension on the part of the general public, or so little agreement as to causes and results among those who have made it a matter of special investigation.* It is of the first importance, therefore, for the understanding of the past involved economic disturbances, that a clear and succinct statement of what has happened should be presented, and such a statement it is now proposed to attempt.

For many years prior to 1873 the bullion price of silver remained very nearly constant at from 60 to 61 pence per ounce on the London market, while the market ratio of gold to silver, or the ratio according to which gold and silver could be interchanged, was limited in London, from 1851 to 1872 inclusive, to a range of variation of from 1 to 15·19 (the minimum) in 1859 to 1 to 15·65 (the maximum) in 1872.†

In 1873 the new German Empire—recognizing the importance of having a monetary system better suited to her advanced industrial and commercial situation than that which she then possessed, and also the desirability of having a uniform coinage throughout the numerous small states that had come to be included under an Imperial Government—took advantage of the command of a large stock of gold, that had accrued through the payment by France of an enormous war indemnity,‡ to effect reform. An exceedingly miscellaneous system of coinage and currency—consisting of seventeen varieties of gold money; sixty-six different coins of silver, possessing full legal-tender powers and constituting (in 1870) 65·7 per cent of the entire circulation; forty-six kinds of notes issued by thirty-five different banks, besides state paper money of various kinds to the extent of 7·5 per cent of the cir-

* "It has been my experience, that about nine men out of ten, even of those who might be expected to have some definite views upon the subject, when asked their opinion upon the expediency or necessity of adopting a bimetallic monetary system, will reply, Oh, that is a very important question, but I do not pretend to understand it.'"—EDWARD ATKINSON, *British Association Proceedings, 1887.*

† Pixley and Abell's "Tables," London.

‡ The amount in gold which France paid to Germany directly was $54,000,000; but in addition there were French bills of exchange which gave Germany a title to gold in places like London, on which such bills were negotiated.

culation—was accordingly called in, and replaced by a new system of gold and silver coinage and paper currency. In this new system, gold was established as the sole monetary standard of the empire, unlimited of necessity in respect to legal-tender powers, while to silver was assigned the function of subsidiary service; and for the latter purpose an issue of silver coinage was provided, not to exceed in the aggregate 10 marks ($2.50) for each inhabitant of the empire (a comparatively low figure), with its legal-tender value limited to 20 marks ($5). An issue of new paper currency was also authorized, with a prohibition of the use of notes of a less denomination than 100 marks ($25), to be distributed according to population among the various states, and redeemable in the new imperial coinage. A proportion of the old silver coinage, which, having been supplanted by gold, was not needed for recoinage under the new system, was offered for sale in the open market as bullion, and the amount actually sold between 1873 and the end of May, 1879, when the sales were suspended, realized $141,784,948. Of this aggregate, $45,644,311 was sold between the years 1873 and 1876, and $96,140,627 between 1877 and 1879 inclusive.

Concurrently with this action of Germany the bullion price of silver began to decline, and this decline was undoubtedly further promoted by the subsequent action of the so-called "Latin Union"—comprising the four countries of Europe using the franc system, namely, France, Belgium, Italy, and Switzerland—which, fearing lest the silver liberated from use in Germany, and offered for sale, would flow in upon and flood their respective mints, to the entire exclusion of gold if the free coinage of silver was continued; first restricted (in 1874), and finally (in 1877–'78), owing to the continued decline in the value of silver, entirely suspended the coinage of silver five-franc pieces. The coinage of subsidiary silver, or silver of smaller denominations than five francs, was, however, permitted and continued.

In 1873, also, the Congress of the United States, in revising its coinage system, dropped from the list of silver coins authorized to be thereafter issued from its mint, the silver dollar of $412\frac{1}{2}$ grains, although providing for the unlimited issue and coinage of silver in pieces of smaller denominations than the dollar; and mainly for the reason, that this particular silver coin was not then in circulation in the country, and indeed had not been for a period of more than twenty-five years.

The extent of the decline in the price of bar-silver per standard ounce, in pence, upon the London market since 1873, is shown by the following exhibit of annual average quotations:

1873, $59\frac{1}{4}$*d.*	1879, $51\frac{1}{4}$*d.*
1874, $58\frac{5}{16}$*d.*	1883, $50\frac{3}{4}$*d.*
1875, $56\frac{7}{8}$*d.*	1885, $48\frac{9}{16}$*d.*
1876, $52\frac{3}{4}$*d.*	1886, $45\frac{3}{8}$*d.*

In July, 1886, the price of silver temporarily fell to $42\frac{1}{2}$*d.* per ounce—the lowest price ever known in history—but reacted in October of the same year to $45\frac{1}{6}d$. From January to September, 1887, the average price was $46\cdot8d.$, declining to $44\frac{1}{8}d.$ in October.

During the early years of the decline of silver, the opinion was extensively entertained, that it was primarily and mainly occasioned by the new supply to the world's market, consequent upon the sales of silver by Germany,* and this opinion found so much of favor with leading German bankers, that it is understood that Germany suspended her sales of silver in 1879 in accordance with their advice, and with the expectation that a partial or entire recovery of price would thereby ensue. But no such result, as is well known, followed the suspension of sales thus recommended. How little, moreover, there was of foundation for this opinion, will appear from the following circumstances:

The aggregate silver product of the world during the years (1873–'79), when Germany was selling her discarded coinage, was $581,800,000, or more than four times the amount of the sales ($141,781,000) which Germany actually effected. Again, during the same period of years when Germany was increasing the world's supply of silver, through her sales, to the extent of $141,781,000, the United States drew upon and reduced this same supply by increasing her dollar and subsidiary coinage to the amount of $111,307,187.† Surely the world's status of silver during these years must have been one of extraordinarily unstable equilibrium from antecedent causes, threatening serious fluctuations in price even in the absence of anything abnormal, if the addition of so small a net product during six years as $30,473,000 to the current market supply of silver could depress the average bullion price of the world's mass of this metal from $59\frac{1}{4}$ to $51\frac{1}{4}$ pence per ounce, or over thirteen per cent.

That the term "unstable equilibrium" is truly expressive of the real status of silver in 1873 would further appear from the following evidence: There was a well-recognized movement in France against silver and in favor of gold from 1853 to 1865, and its influence would probably have shown itself in a fall in value of silver, had it not have been for the cotton-famine consequent on the American war, which occasioned extraordinary shipments of silver to India, and so counter-

* The amount of silver (old coin) which Germany up to 1880 was able to sell, as the result of her policy of displacing silver by gold, has been estimated at $270,000,000. Of this amount $111,781,000 had been sold up to May, 1879, when the sales were suspended; and since then, it is understood, that only a few additional millions have been marketed, i. e., to Egypt. In addition, Denmark, Sweden, and Norway, which followed the lead of Germany, and changed their silver circulation to gold, have since thrown upon the market about $9,000,000 of silver. (See LAUGHLIN'S *History of Bimetallism in the United States*, pp. 141–145.)

† During the twenty years from 1853 to 1873, the aggregate silver coinage of the United States was $57,137,000, or an average of only $2,856,000 per annum, and of this aggregate but $5,538,948 was in the form of silver dollars. From 1874 to 1879, inclusive, the silver coinage of the United States was 35,859,360 trade-dollars, 35,801,000 standard dollars, 22,899,785 halves, and 16,747,012 quarters and twenty-cent pieces; total, $111,307,187, or an average of $18,560,000 per annum.

acted any tendency then existing to a surplus in the European markets. In 1867 an International Monetary Conference at Paris voted almost unanimously in favor of the adoption of a single gold standard by the chief commercial nations. As far back as 1860, the late Professor Cairnes, who is recognized as a far-seeing economist, ventured the prediction that silver was in the process of depreciation. Another influence tending to powerfully affect the status of silver in 1873 was due to the circumstance that, subsequent to 1868–'69, the India Council greatly increased the sale of their bills (i. e., drawn on India and payable in silver) on the London market, and so virtually increased the stock of marketable silver at that point to the extent of from $20,000,000 to $30,000,000 annually, in excess of what it had been for the years immediately previous.*

The German "sales" theory being thus untenable, another hypothesis has found wide acceptation—namely, that, notwithstanding any absolute or comparative increase in the supply of silver during recent years, its decline in price and the economic disturbances which are alleged to have followed, would not have occurred, had it not been for the "demonetization" or the general discrediting of this metal for use as money; which has been contingent on the adoption of gold as the sole monetary standard and as a larger instrumentality of exchange by several of the most important commercial countries—notably Germany and the United States; or, as a leading American statesman has expressed it, "but for the striking down of one half of the world's coinage," and "compelling gold to do the work of both gold and silver." But here, also, the evidence in confirmation of this hypothesis is exceedingly unsatisfactory or wholly lacking. If by demonetization is meant that there has been less of silver in use and circulation as money, absolutely or comparatively, throughout the world since 1873 than formerly; or that the people of any country have been inhibited to their disadvantage in its use; or that, in consequence of any restrictions on its use for coinage, production and trade have decreased, and the prices of commodities and wages have fallen—the assumptions are not warranted, and the term demonetization is meaningless. The world's average annual production of silver since 1873 has been greater than ever before. Between 1873 and 1887, inclusive, the aggregate

* The Government of India is under obligation to pay annually in England certain fixed charges in gold, the same being in the nature of reimbursements—principal or interest—to England for loans on account of public works in India, receipts from railroads belonging to the British Government, pensions chargeable to India, etc. India being exclusively a silver-using country, pays its taxes and railroad freights and fares, etc., exclusively in silver; and in liquidation of its foreign monetary obligations, silver is remitted to London in the form of bills (exchange) payable in the silver currency of India, namely, rupees, which are drawn by the India Council, or the Government of India residing in London. It must be obvious that to just the amount of such council bills or drafts as are sold in London, to just that same extent the exportation of silver for business purposes is supplemented or made unnecessary.

product—measured in dollars of 412½ grains each—has been in excess of $1,250,000,000, and most of it has passed into circulation as coin, or lies piled up in national depositories awaiting any popular demand for its employment;* and the greater number of the daily transactions of trade continue to be settled by the use of silver, just as formerly. "If you take," says Mr. Robert Giffen, in his testimony before the British Gold and Silver Commission, 1886, "the fifteen years from 1870, and compare them with the fifteen years before, you will find that the practical diminution for the demand for silver in France, and I suppose it has been the same in other Latin countries, has not been sensible at all." The continually increasing importation of silver into India, China, Burmah, and Japan is conclusive also as to the absence of any restrictions on the use of this metal for coinage purposes in these countries.† In short, all that is now claimed by one of the most distinguished economists who inclines to the view that the monetary use of silver has been artificially restricted, is that its employment for coinage might possibly have been greater if it had not been for the action of the Latin Convention countries.‡ But it is obvious that this opinion must be necessarily a matter of conjecture.

Again, the world has never made so great a progress in respect to all things material in any equal number of years as it has during those which have elapsed since silver began to decline in price in 1873. Never before in any corresponding period of time has labor been so productive; never has the volume of trade and commerce been greater; never has wealth more rapidly accumulated; never has there been so much abundance for distribution on so favorable terms to the masses; never, finally, would an ounce of silver exchange for so much of sugar, wheat, wool, iron, copper, coal, or of most other commodities, as at present. If the fall in the price of all desirable commodities has been an evil, as not a few seem to believe, it can not be conclusively proved, in respect to even one article, that any such

* The number of standard silver dollars in the United States in 1879, the year of the redemption of specie payments by the Federal Government, was reported at 35,801,000. The number coined between March, 1878, and August 31, 1887, was 270,200,117, of which 65,336,063 remained at the latter date in the Federal Treasury, after deducting the silver held for the redemption of silver certificates in circulation. The Mint estimate of the silver coin in circulation in the United States in 1886 (dollars and subsidiary) was $308,784,223.

† During the fifteen years from 1855 to 1870 the annual demand of India for silver was very nearly £10,000,000. This period embraced the cotton-famine. From 1872 to 1875, just before the drop in silver, the amount that India annually received was £3,000,000. From 1875 to 1880 it was £7,000,000; from 1880–'85, £6,000,000; and for 1885–'86, nearly £12,000,000.

‡ "The suspension of the free coinage of silver by the Latin Union operated not to diminish the actual employment for silver as compared with what had been in existence before 1872, but a possible employment which might have come into existence if the law had not changed."—(See testimony of Mr. Robert Giffen, British Gold and Silver Commission, First Report, p. 28.)

fall has been extensively due to any decline in the value of silver or any appreciation of gold.

On the other hand, a more rational explanation of the decline since 1873 in the value of silver, and one which the logic of subsequent events is substantiating, would appear to be as follows: Since 1860 the annual product of silver has been rapidly increasing—i. e., from $40,800,000 in 1860 to $51,950,000 in 1865; $61,050,000 in 1871; $80,500,000 in 1875; $96,000,000 in 1880; $124,900,000 in 1885.* The aggregate product from 1860 to 1873, inclusive, was $990,000,-000. Previous to 1871–'72 neither France nor the Latin Convention states of Europe had been large consumers of silver. In fact, from about 1850 to 1864, France, instead of being a consumer, was really a seller of silver, and during that period disposed of about £75,000,000 ($375,000,000). After 1864 the tide turned, and France began to take back silver, but up to 1873–'74 her imports had by no means balanced her previous exports. M. Victor Bonnet, writing in 1873 ("Revue des Deux Mondes"), after the greater part of the French indemnity had been paid, estimated the quantity of specie remaining in the possession of the French people at 6,000,000,000 francs ($1,200,000,000). China, also, which previous to 1864 had been a silver-importing country, after 1864 and until up to about the time of the drop in silver, became a silver-exporting country.† From 1853 to 1873, inclusive, the United States furthermore coined but very little silver, and during this whole period drew on the world's supply of silver for coinage purposes to an extent (measured in dollars) of only $57,137,000; while, during her long period of suspension of specie payments, subsequent to 1861, her stock of silver coin entirely disappeared from circulation, and in great part was doubtless added to the supply of other countries.

Under such circumstances, which were perfectly well known to the custodians and dealers in silver everywhere, Germany entered the world's market as a seller of silver. The amount offered at first was absolutely very small and comparatively insignificant, but it nevertheless probably constituted a supply in excess of any current demand. As the states of Europe and the United States could not at once increase their consumption and import of the products of Asia, Africa, and South America, and so increase their sales (exports) of silver, and, as the price which the surplus of any commodity forced for sale will command determines the price of the whole stock of such commodity, the price of the whole stock of silver bullion naturally began to decline. The general policy of Germany respecting the use of silver for coinage, which was subsequently favored and adopted by Sweden, Norway, Denmark, and Holland, with the concurrent suspen-

* The average annual production of silver, according to M. Soetbeer, was $24,334,750 from 1811–'20; $20,725,000, 1820–'31; $26,840,000, 1831–'40; $35,118,000, 1841–'50.

† Testimony of Mr. Robert Giffen, First Report of the British Gold and Silver Commission, p. 29.

sion by the states of the Latin Union of the free coinage of the silver five-franc pieces, also unquestionably favored and intensified the decline in the price of silver thus inaugurated, by creating an apprehension (or scare) among the bullion-dealers as to what might further happen.

The continued decline in the value of silver in more recent years—i. e., from an annual average of $51\frac{1}{4}d.$ in 1879 to $45\frac{3}{8}d.$ in 1886—may also be rationally referred to a continuance of the same influences. The annual product of silver has continued to increase—i. e., from $96,000,000 in 1879 to $124,900,000 in 1886, or $762,000,000 in the aggregate for this period. No one knows what is to be the product of silver in the future; but it is reasonable to believe that, if the price of silver were to advance materially, its product would be largely augmented. Recent reports made under the auspices of the Mexican Secretary of the Interior, and published in the "Mexican Economist" (1886), claim that the cost of working the argentiferous lead-ores of Mexico, which "exist in prodigious abundance," has been greatly reduced within recent years, and that under a better system of taxation and with an adequate supply of capital the annual product of the silver-mines of Mexico could be quickly doubled and even trebled. Furthermore, an average decrease of at least thirty per cent in the prices of the commodities that represent the great bulk of the world's production and consumption (comparing the data of 1885–'86 with those of 1867–'77) has in itself been equivalent to largely or entirely supplementing any increased demand for the use of silver and gold as money, consequent upon any increase in the volume of the world's business during the same period. The constantly-increasing tendency of civilized countries to use less and less of coin in the transaction of business, and the continued invention and successful application of numerous and unprecedented devices for economizing the use of metallic money, must at the same time have been equivalent to a constant comparative increase in the supply of precious metals for coinage purposes. Still another factor exercising a disturbing influence on the price of silver, and preventing its price recovery, undoubtedly grows out of the fiscal relations of Great Britain with India. The regular annual sales at London of India Council bills—the character of which has been heretofore explained (see page 173)—are in the nature of forced sales of silver, and at present average about $45,000,000 per annum. How much effect these sales, at the point where the silver-bullion trade of the world centers, have had in depressing the market price of silver, is undetermined; but that it has not been unimportant can not well be doubted.

Attention is next asked to the character of the economic disturbances which have resulted from the change since 1873 in the relative values of gold and silver. Omitting from consideration the extreme views on this subject, in which silver seems to be regarded in the sense of a personality that has been unjustly and designedly "outlawed" and deprived of some ancient prerogative, the disturbances in question are the same in character as have always accompanied the use of a depreciated, fluctuating currency, with this additional and novel peculiarity—namely, that while, heretofore, depreciation of currency has been due to the forced issue of redundant and irredeemable paper money or debased coin, and has been local in its influence, the present experience is due to a depreciation in the value of one of the precious metals with reference to the other, and extends to many countries in very different degrees. Let us particularize these disturbances, and see how serious or otherwise have been their resulting influence.

In the United States, all the evil which has thus far been experienced has been solely from apprehensions of evil in the future, which in turn have been occasioned by the circumstance that the United States, in harmony with her protective policy, buys from the owners of the (present) most productive and cheaply-worked silver-mines in the world, silver bullion for coinage to the value of $2,000,000 monthly, irrespective of any current demand or necessity for such coinage on the part of her own people. In the coinage system of Great Britain the function of silver remains as it has for a long period, almost as unimportant as that of copper. In Germany, "although the imperial mark is now everywhere recognized as the standard, all Germans, whether they live in Bavaria, Prussia, or Hanover, are able to sell their commodities with the consciousness that the 'marks' they receive in payment for them are good money, with the same purchasing power, whether paid out as silver thalers or as gold crowns." * Furthermore, at a meeting of the representatives of the various Chambers of Commerce in Germany, in March, 1887, seventy-one chambers to four voted against any change in the existing monetary policy of the Empire. In the other states of Europe, the currencies of which are on a specie-paying basis, the situation is substantially the same as in Germany.† In exclusively silver-using countries, like India and Mexico, the decline in the value of silver has not appreciably affected its purchasing power in respect to all domestic products and services; but the silver of such countries will not exchange for the same amount of gold as formerly, and it might be supposed that, owing to this change in

* Communication by a director of the Bank of England (Mr. H. H. Gibbs) to the "Dar Kampf unc die Währung," Berlin, April 30, 1886.

† "There are no indications of any change in the policy of the fiscal authorities of the several states visited by me (Great Britain, France, Germany, Belgium, and Holland) which warrant any expectation that the subject of a bimetallic treaty for a common legal tender, coupled with the free coinage of silver, will be seriously considered at the present time by them. . . .

"There is no indication that the subject of bimetallism has received any intelligent or serious consideration, outside of a small circle in each country named, as a probable or possible remedy for the existing causes of alleged depression in trade."—*Report to the President of the United States "On the Present Status of Bimetallism in Europe," October, 1887, by* EDWARD ATKINSON.

the relative value of the two metals, the silver of India, Mexico, and other like countries would purchase correspondingly less of the commodities of foreign countries which are produced and sold on a gold basis. But the people of such countries have not thus far been sensible of any losses to themselves thereby accruing, for the reason that the gold prices of such foreign commodities as they are in the habit of buying have declined in a greater ratio since 1873 than has the silver which constitutes their standard of prices—a condition of things which Don Francisco Bulnes, the distinguished Mexican economist, in a recent official report, has exemplified to his countrymen by the following felicitous illustration:

"Two merchants, named Mexico and Foreigner, exchange annually cotton shirtings for silver dollars: Mexico delivers $100, and receives from Foreigner one hundred pieces of cotton shirting. By the depreciation of silver, it results that Foreigner only wishes to accept the Mexican dollar for eighty-six cents for each one, but gives in exchange each piece of cotton shirting for sixty-six cents. Which of the two will be the loser?" Nevertheless, if silver had maintained its former relative value to gold, the benefit accruing to silver-using nations from the decline in the prices of commodities through improvements in their production and distribution might have been greater; but, if so, the loss does not appear to have been made by them a cause of complaint.

All the evidence seems to indicate that the economic disturbances contingent on the decline in the value of silver, apart from what have been due to the apprehension of evil (or scare), have thus far been almost exclusively confined to the trade or financial intercourse between the gold-standard and the silver-standard nations, or between the states of Western Europe and the United States, and the nations of the Eastern hemisphere and of Central and South America; and that the manifestations of these disturbances have been greatest in England and Holland, where the foreign trade of the silver-using countries largely centers. And it seems further to be admitted that these disturbances have not resulted so much from a fall in the value of silver *per se* as from the uncertainties or fluctuations in its price, or, as commonly expressed, in the rates of exchange—an eminent merchant of Manchester, England, largely engaged in trade with India and the East, being reported as saying, at the last meeting of the British Association (September, 1887), that with the present excellent telegraph service, and a level (non-fluctuating) monetary basis, exchange in India would be as steady as in New York. In all this, there is, however, nothing unprecedented or in the nature of the unexpected; nothing which the world has not heretofore repeatedly experienced. For it is to be remembered that fluctuations in exchange are the invariable accompaniment of trade with nations using a depreciated and fluctuating currency; and that there is no good reason for supposing that the disturbances which have characterized the trade of Europe with India and the East during recent years, from fluctuations in the price of silver, have been any different in kind than, or as great in degree as, those which characterized the trade of Europe with the United States from 1861 to 1879, or which characterize to-day the trade of the outside world with Russia, whose currency is depreciated and fluctuating. Moreover, the difficulties arising from the uncertainties of exchange, at least between England and India, appear to have been greatly exaggerated. Mr. Lord, a director of the Manchester (England) Chamber of Commerce, testified before the Commission on the Depression of Trade, in 1886, that, "so far as India was concerned, it is not necessary to run any risk at all," from the uncertainties of exchange. Mr. Bythell (representing the Bombay Chamber of Commerce) testified before the same commission: "He [Mr. Gibbs] says that commerce with India is paralyzed. I deny the assertion. There is no difficulty in negotiating any transaction for shipping goods to India, and in securing exchange." It is also beginning to be generally recognized that, owing to telegraph correspondence and rapid steam communication, the risk in transacting business between different countries, contingent on fluctuations in exchange, is being gradually eliminated, inasmuch as sales and purchases, or remittances, and all the incidents of exchange, freights, commission, etc., can be practically arranged between the operators at one and the same time.*

But whatever may have been the disturbances resulting from fluctuations in rates of exchange between Great Britain and the silver-using countries (of which India is the chief), contingent on the fluctuations in recent years in the price of silver, these disturbances do not appear to have had any effect up to 1884–'85 in checking the volume of British trade with Eastern nations, or in changing the relations of exports and imports that previously existed. Thus, from returns officially presented to the British Gold and Silver Commission, 1886, it was established that the trade of Great Britain with India since 1874 had relatively grown faster than with any foreign country, "except the United States and perhaps Holland." Assuming 100 to represent the trade between the two countries in 1874–'75, the imports from the United Kingdom into India rose from 100 to 154 in 1884–'85, and the exports from India to the United Kingdom from 100 to 149. Much also has been said respecting the serious injury which the export trade in cotton manufactures from England to India has sustained in recent years

* "If trade can go on profitably between countries having an inconvertible paper of a widely fluctuating kind and the rest of the world, *a fortiori*, it can go on between gold and silver countries. The exchange is a hindrance and obstacle, as many other things are hindrances and obstacles, but it is nothing more. . . . Such difficulties are the ordinary incidence of trade and life, and will be dealt with like other difficulties of a far more serious kind by those concerned."—*London Times, September 14, 1886.*

in consequence of the "dislocation" of the money of England's Indian customers. But the facts do not bear out such statements. Taking the number 100 as representing the condition of the cotton-fabric export trade of England with India in 1874, the numbers for 1876 were, respectively, 134 for quantity and 96 for value; and this change in value, as was testified to before the Gold and Silver Commission, has "occurred since 1883"; or was coincident with a recognized increase at that date in the manufacturing capacity of the cotton-factories of Europe and the United States, greatly in excess of any current market demand for consumption.*

In like manner the official returns also show that while India during recent years has largely increased her exports of domestic cotton fabrics—cloth and yarn—to China and Java, the exports of like products from England to these same countries from 1875 to 1884–'85—the period covering the greatest decline in the price of silver (or of the fall in exchange)—also continually increased; or for 1884 were 14 per cent in the case of piece goods, and 32 per cent in yarn, greater in the aggregate than they were in 1875. Since 1884–'85 the condition of the British export trade to China is reported to have been less favorable.

It might also seem that the Government of India, in selling its remittances in silver—India Council bills—to cover its liabilities in England, for a less price in gold than formerly, constantly experiences a loss; but, on the other hand, it is well established that the increase in the revenues of India, since the decline in silver began, owing to the increased prosperity of the country and the increased receipts of the government railways, fully counterbalances any loss they may have incurred in remitting silver against their gold liabilities.

Another pertinent example, and one not in any way connected with the trade of Europe or India, is afforded by the recent trade experiences of Mexico. This country has almost exclusively a silver currency; and the fluctuations in the price of silver since 1873—Mexican exchange having varied in New York in recent years from 114 to 140 †—would seem necessarily to have been a disturbing factor of no little importance in the trade between the United States and Mexico. But

* In 1870 the British export of cotton piece-goods to India was returned at 923,000,000 yards, representing 28·4 per cent of the entire trade of the United Kingdom with India. In 1884 the export of these same goods was 1,791,000,000 yards, or 40·6 per cent of the entire trade. In respect to cotton yarns the British exports to India for 1870 were 31,000,000 pounds, or 16·5 per cent of the total exports; and in 1884, 49,000,000 pounds, or 18·1 per cent of the total exports. The bulk of the trade of Great Britain is with gold-using countries; and yet, while the trade of India with Great Britain was 8·3 per cent of the whole trade of the kingdom in 1870, it constituted in 1883 as much as 9·9 per cent of the whole trade.—*Testimony before the Gold and Silver Commission of* Mr. Henry Waterfield, *Financial Secretary of the India Office, London.* (See First Report of Commission, pp. 122, 123.)

† That is, one hundred and forty Mexican dollars to one hundred dollars of the United States gold standard.

the official statistics of the trade between the two countries since 1873 (notoriously undervalued) fail to show that any serious interruption has occurred; the domestic exports from the United States to Mexico having increased from $3,941,000 in 1873, to $11,089,000 in 1884; while the exports from Mexico to the United States during the same period increased from $4,276,000 to $9,016,000.

In recent years there has been a notable increase in the cotton-manufacturing industry of India—i. e., from fifteen factories, with 450,156 spindles and 4,972 looms in 1873, to seventy factories, with 1,698,000 spindles and 14,635 looms in 1884; and the cause of this increase, which is enabling India to compete (as never before) with Lancashire (England) in supplying cotton yarn and fabrics to the Indian and other Eastern markets, and to the alleged serious detriment of English interests, is popularly believed and asserted to have been occasioned mainly by the decline and fluctuations in the price of silver. The cross-examination of experts in the Anglo-Indian trade by the British Gold and Silver Commission conclusively showed, however, that the prime cause of the increasing ability of India cotton-manufacturers to compete successfully with those of England is to be found in the advantages which accrue to the former from the lower wages and longer factory-hours* of their employés. But the existing differences as respects the condition of labor in England and India have existed from time immemorial; and the only novelty of the present situation is, that now India, with railroads and factories, and the advantage of cheap ocean freights, is emancipating herself from chronic sluggishness and beginning to participate in the world's progress; and under English auspices, and largely with English capital, is, for the first time, extensively utilizing her cheap and abundant labor in connection with labor-saving machinery. And it is to be further noted that her progress in cotton manufacturing exhibited itself unmistakably some years before the commencement of the decline in silver; that the first shipment of cotton yarns from India to China, in competition with yarns of English make, was in 1866, and that between 1865 and 1873 the increase in the number of cotton spindles in India was in excess of 57 per cent.

The belief is also very general that the decline in silver has abnormally stimulated exports from silver-using countries, to the great detriment of the wheat-growers of the United States and Australia, who offer their surplus in competition with the surplus of India upon the European market. Nothing is easier than to get into a state of mental confusion in respect to this matter, and, in fact, there seems to be no assignable limit to the multiplication of words upon it.

* The hours of labor in the factories of Bombay are reported at eighty per week in comparison with fifty-six per week in England. The wages of skilled labor in Bombay, in common with the wages of similar labor in countries of the western hemisphere, are reported to have materially advanced in the recent years.

But, in forming an opinion concerning it, it is important to steadily keep in mind the fact, that international trade is trade in commodities, and not in money; and that the precious metals come in only for the settlement of balances. In fact, all such exchanges are, to within a very minute fraction, the result of an organized and elaborate system of barter, and the principle of barter prevails in them, and determines to a great extent the methods employed. The trade between England and India is an exchange of service for service. Its character would not be altered if India should adopt the gold standard to-morrow, or if she should, like Russia, adopt an irredeemable paper currency, or, like China, buy and sell by weight instead of tale. Will India give more wheat for a given amount of cloth because she uses silver instead of gold in her internal trade? Will England give less of cloth for a given amount of wheat because she keeps her accounts in pounds, shillings, and pence instead of in rupees? Unless all the postulates of political economy are false—unless we are entirely mistaken in supposing that men in their individual capacity, and hence in their aggregate capacity as nations, are seeking the most satisfaction with the least labor, we must assume that India, England, and America produce and sell their goods to one another for the most they can get in other goods, regardless of the kind of money that their neighbors use or that they themselves use. A silver currency does not give any additional strength to a Hindoo ryot, nor does it increase the fertility of his soil, or add to the number of inches of his rainfall. Nor does a gold currency detract in any way from the capability and resources of his rival, the American farmer. Nor does the difference in their respective currencies affect the judgment of the buyer of wheat in Liverpool. Is any single factor in the elements of production and transportation, by which alone the terms of competition are settled, changed by the local currencies of the several countries, or the mutations thereof? Surely no mutations were ever more sudden or violent than those of the currency of the United States during the late war. They were not without their effects; but the effects were not of a kind to change the terms of competition in international trade.

It may be that the Indian wheat-grower has been enabled by the decline in silver to get labor for less wages than before, and has thus gained an advantage over his competitors in America and Australia; but the evidence is all to the effect that wages generally in India in recent years have advanced and not declined. But the terms of international competition are not altered by any division of the joint product of labor and capital in one of the competing countries. The person that has the most of a grievance growing out of the present state of the wheat-trade is the American farmer, who is restricted from buying in the same market in which he sells his surplus wheat to as good advantage as his competitors; but this is not due to any change in the value of silver, but to the fiscal policy of his own Government.

The whole subject of the disturbing influence of the decline in the value of silver on the trade between gold and silver using countries is complicated and difficult of analysis, and the opinions of persons practically interested in such trade are not harmonious; but it is difficult to see how one can investigate the subject, with the light of the experience which the years that have elapsed since 1873 has contributed, without coming to the conclusion that the seriousness of the disturbances has been greatly exaggerated, and that the expediency of attempting to provide remedies by legislation for such as may be acknowledged to exist—if legislation were practical—is very doubtful.*

One feature contingent on the fall in the value of silver, which appears to be regarded in England somewhat in the light of a popular grievance, is the decline in the value of the pensions, or "half" pay allowances which have been given by the Indian Government to their retiring officials for good and extended service. These pensions are granted in India, and are payable there in the current money of the country—i. e., the silver rupee—and, before the decline in silver, had an equal purchasing power with gold; and at the present time, so far as these pensions are spent in India, no loss occurs, because the purchasing power of silver in that country has not fallen materially. But, on the other hand, if the rupees are remitted to England, and sold there at the price of bullion, or if, what amounts to the same thing, the remittance is effected by the purchase of a bill of gold exchange on England, the loss in English money to the pension or half-pay recipient residing in England is considerable, and has been estimated to average about 25 per cent. At the same time, it is to be remembered that there has been no loss, but rather a gain, in the present purchasing power of silver, as compared with its purchasing power at the time when the pensions or half-pay in question were granted.

* In connection with this subject, the following extract from the record of the examination of Mr. H. Waterfield, Financial Secretary of the India Office, London, before the British Trade and Silver Commission (February, 1887), will be read with interest:

Question (Sir T. Farrer). "So that, while India has been doing much more, Lancashire has been doing more than she did before?"

Answer. "Yes."

Q. "Then I will ask you, do the figures [submitted] justify the statement that the present state of things—that is, the fall in exchange—is causing the gradual transfer of the yarn-trade of China to India; that the exports from England have steadily declined since the fall of silver commenced, while those from India have enormously increased?"

A. "The increase of the imports from India may, indeed, be termed enormous; but it is not correct to say that the exports from England have steadily declined since the fall of silver commenced; and I think that the fall in exchange is not the cause of the improvement in the Indian trade."

Q. "At any rate, you would not see in these figures any reason for protecting Lancashire against India by a radical alteration of our currency system?"

A. "No; I should think it as objectionable as allowing any protection of India against Lancashire."

It is not alleged that the Indian Government has violated any contract or stipulation; but that they "have proved ungenerous employés."* Important, however, as this matter doubtless is to those especially interested, it is one in which the world at large can not be expected to take much interest.

In Holland the disturbances assumed to have been occasioned by the decline in the value of silver have attracted public attention to an even greater degree than in England. But even here the disturbances have been mainly restricted to the commercial and financial relations of Holland with her East Indian colonies, Java, Sumatra, and other islands, and have been specially occasioned by the extraordinary fall in recent years in the prices of the principal exports of these islands, namely sugar and coffee. But no commercial fact is capable of more complete demonstration than that the fall in the price of these great staples has been in no way contingent upon any change in the value of silver.†

Finally, the idea of disturbance in connection with the decline in the value of silver has been and is pre-eminently connected with an annunciation and belief in two propositions: First, that the almost universal decline in the prices of the world's staple commodities since 1873 has been occasioned by the fall in the price of silver; and, second, that a decline of prices is an evil. The first of these propositions rests upon an assumption which can not be verified by any conclusive evidence whatever; and, as for the second, if the fall of prices has been mainly due, as has been demonstrated, to natural and permanent causes, namely, the increased power of mankind in the work of production and distribution; then the result, by creating a greater abundance of all good things, and bringing a larger amount of the same within the reach of the masses for consumption and enjoyment, has been one of the greatest of blessings.

* It is curious to note that when the rules regulating the pensions of the Indian Civil Service were established in 1863, the Indian Government stipulated that the rupee should not count for more than two shillings, which had been about its equivalent in sterling from time immemorial, even if at any time exchange on England rose to a higher point (as it actually did at one time, in 1861); but, not expecting that the rupee would ever fall in value to any great extent below 2*s.*, or below that par of exchange, they omitted to provide against it.

† "During the last five years Java has been subject to the most fearful natural calamities. They have had a cattle plague which destroyed almost the whole cattle in parts of the island; they have had cholera; they have had earthquakes of an unprecedented character, and they have had further an extraordinary fall in the values of their principal exports, which are sugar and coffee, owing, in the first place, to the competition of beet-root sugar in Europe; and, in the second place, to the fact that South America has been able to export coffee more favorably than Java; and to this extent we can trace a loss of £5,000,000 annually in these two articles. That has been the result in the last five years of natural causes, without any question of currency at all."—*Testimony of* Mr. Paul F. Tidman, *East India merchant. First Report of the British Gold and Silver Commission, p. 142.*

Any discussion of the economic disturbances resulting from changes in the relative values of the precious metals, would be incomplete, that failed to point out how the events that originated the so-called "bi-metallic" controversy were the natural outcome of the revolutionary changes in the methods and production and distribution that have occurred in recent years in all countries in proportion to their advance in civilization.

It is not easy to imagine that any person of ordinary intelligence can seriously believe, that the enactment of laws looking to the recognition of gold as the single standard of value, thereby effecting what is called the demonetization of silver, could ever have resulted from mere whim or caprice, or with a view of occasioning either domestic or international economic disturbance. There was a time when nations, with the expectation of receiving benefit, did adopt policies and enact laws with the undisguised and sole intent of injuring the industry and commerce of neighbors with whom they were at peace; but happily such days have long past. And the inference is, therefore, fully warranted that whatever steps have been taken, which have resulted in any territorial restriction of the use of silver as money, have been in consequence of a belief by the parties—nations—thus acting, that such a policy was called for by change in the economic condition of their affairs, and was likely to be to them productive of benefit. And the answer to the pertinent question as to what *benefit*, is simply, that which might be expected to accrue from the using of the best rather than an inferior tool; of a money instrumentality adapted to new, rather than to old conditions of production and distribution.

One needs but to stand for a brief time at the marts of trade in countries of varied degrees of civilization, to quickly recognize and understand, that the kind of money a country will have and use, depends upon and will vary with, the extent and variety of its productions, the price of its labor, and the rapidity and magnitude of its exchanges; and investigation will further inform him that when mankind, savage, semi-civilized, civilized, or enlightened, find out by experimentation what metal or other instrumentality is best adapted to their wants as a medium of exchange, that metal or instrumentality they will employ; and that statute law can do little more than recognize and confirm the fact. In truth, legislation in respect to money, as is the case in respect to other things, never originates any new idea; "but merely enacts that that which has been found beneficial or prejudicial in many cases, shall be used, limited, or prohibited in all similar cases within its jurisdiction." Thus, in all countries where prices are low, wages small, transactions limited, and exchanges sluggish, nothing more valuable can be used as money for effecting the great bulk of the exchanges, than copper; and in countries like Mexico and China, even the copper coin corresponding to the American "cent," the English "half-penny," and the French "sou" is often so disproportionate in point of value to the wants of retail trade, that in the former country it is made more useful by being halved and quartered, and in the latter is replaced with some even cheaper metal, as iron, or spelter. The wages in all such countries do not in general exceed twenty to twenty-five cents a day, and the sum of such wages, when represented in money, must be capable of division into as many parts in order to be exchanged for the many daily necessities of an individual or a family. But with wages at twenty-five cents per day, the use of coined gold would obviously be impracticable. The equivalent of a day's labor in gold would be too small to be conveniently handled; the equivalent of an hour's labor would be smaller than a pin's head. And in a lesser degree would be the inconvenience of using coined silver for effecting the division of similar small wages.*

In countries of higher civilization, but still of comparatively low prices and limited exchanges (and these last mainly internal or domestic), silver naturally takes the place of copper as the coin medium of exchange and as the standard of value; and as more than a thousand million people are the inhabitants of such countries, silver, reckoning transactions by number and probably also by amount, is to-day the principal money metal of the world.

On the other hand, in countries of high wages, rapid financial transactions, and extensive foreign commercial relations, the natural tendencies are altogether different, and favor the more extensive use of gold for money, without at the same time displacing from their legitimate monetary spheres either copper or silver.

The metal coinage system of the world is not therefore "mono-

* In many of the sugar-producing islands of the West Indies, the greatest number of the separate retail purchases at the established stores do not exceed from two to three cents in value. In the Island of Trinidad, probably 75 per cent of an annual importation of about 22,000,000 pounds of breadstuffs (110,000 barrels) pass into the ownership of the laboring-classes (whose average annual consumption is estimated at 31 pounds per head), through purchases for cash of quantities rarely exceeding a pound at any one time.

Corea, a country which until recently has been almost unknown to the civilized world, affords another striking illustration of the principle that the kind of money a people will have and use, if left free to choose, will be determined by the nature of their exchanges, through what may be termed a natural process of evolution, and not by artificial arrangements. Thus, Corea has been proved to be a very poor country; raising little more of any one product than will suffice for home consumption; and with a very restricted internal trade, owing to small production and the lack of facilities for personal intercommunication and product distribution. To a majority of her people a monthly income equivalent to two or three dollars, is represented to be sufficient to meet all their necessities. Yet even under these unfavorable and limited conditions of exchange, money has been found a necessity; and has come into use in Corea, in some unknown manner, in the shape of small metallic coinage—nominally copper, but really a sort of spelter-piece —500 to the dollar. With the opening of the ports of the country, a demand for certain foreign products has been created; and these, when obtained in exchange for hides and gold-dust, are sold to the people in quantities so small, that only coins of the value and character mentioned can be conveniently used as media of exchange—kerosene, for example, being sold by the half-gill, and matches in bunches of a dozen.

metallic," nor "bi-metallic," but tri-metallic; and the three metals in the form of coin, have been used concurrently throughout the world ever since the historic period, and in all probability will always continue to be so used; because by no other system that has yet been devised can the varying requirements of trade in respect to instrumentalities of exchange and measures of value be so perfectly satisfied. And the only change in this situation of monetary affairs has been, that gradually and by a process of evolution as natural and inevitable as any occurring in the animal or vegetable kingdom, gold has come to be recognized and demanded as never before in all countries of high civilization, as the best instrumentality for measuring values and effecting exchanges. It has become, in the first place, the money of account in the commercial world and of all international trade; and any country that proposes to find a foreign market for the surplus products of its labor must employ the very best machinery of trade —railroads, steamships, telegraphs, or money—if it does not propose to place itself at a disadvantage.

In respect to portability, convenience for use, adaptation to domestic and foreign business alike, the balance of advantage for all transactions, above $25 or £5, is also largely on the side of gold; as will be evident when it is remembered that it required, even before its depreciation, sixteen times more time to count silver in any considerable quantity than an equal value of gold; sixteen times more strength to handle it; sixteen times more packages, casks, or capacity to hold it, and sixteen times more expense to transport it. In other words, in this saving age, when the possibility of extensive business transactions is turning on profits reckoned not in cents but in fractions of cents per yard, per pound, or per bushel, to use silver for large transactions in the place of gold, is a misapplication of at least fifteen sixteenths of a given unit of effort, time, expense, and capacity, when one sixteenth would accomplish the same result.

Another factor which has without doubt powerfully influenced public opinion in countries of large and active domestic and foreign trade in favor of gold as the sole monetary standard in preference to silver, has been the advantage which gold seems to possess over silver in the element of stability of cost of production. The amount of labor involved in the mining or washing for gold has remained nearly constant for ages; while in the case of silver not only are new deposits of great richness continually being discovered, but many old mines hitherto unworked and unprofitable by reason of inaccessibility, or by the character of their ores, have been reopened and rendered profitable by improved facilities for transportation and cheaper processes of reduction.

Now, it is not asserted that it was exactly these considerations, as thus specified, that influenced Germany in 1873 to take advantage of the opportunity afforded by the payment of the French war indemnity* to adopt gold as the standard of her metallic coinage system—a policy which France would probably have adopted in 1870, had not war intervened—and that subsequently induced other countries to follow the example of Germany. But it can not be doubted that the motive in general which prompted the action of Germany in 1873, and which to-day enrolls so many of the best of the world's thinkers, financiers, and merchants, on the side of gold rather than that of silver in the pending and so-called bimetallic controversy, has been and is a conviction, that the movement in favor of a gold standard, by highly civilized and great commercial nations, is in consonance with the spirit of the age; that it was a necessity for the fullest development of production and traffic, and the same in kind which prompts to the substitution, regardless of cost, of new machinery for old, if even the minimum of gain can be thereby effected in the production and distribution of commodities. It may, however, be urged that granting all that may be claimed respecting the superiority of gold over silver as a standard of value and a medium of exchange, there is not a sufficiency of gold to supply the wants of all who may desire to avail themselves of its use for such purposes; and therefore, any attempt to effect innovations in former monetary conditions would be impolitic because likely to be generally injurious. But this would not be considered as an argument of any weight if pleaded in opposition to the whole or partial disuse of any other form of tool or machine in order that some better tool or machine might be substituted. That in such a case there would be an advantage to those who could afford to have and use the new, and a corresponding disadvantage to those who could not, may be admitted; but what would be the future of the world's progress, if the use of all improvements was to be delayed until all to whom such use would be advantageous could start on terms of equality?

If, therefore, the above premises are correct; if certain of the leading states of the world have given a preference to gold over silver in their trade, and have selected a single in place of a former double standard of value—not by reason of the adoption of any abstract theory or desire for experimentation, but rather through a determination to put themselves in accord with the new conditions of production and distribution that have been the outcome of inventions and discoveries during the last quarter of a century—then the inference is warranted, that all attempts to enforce, through any international conference or agreement, any different policy or practice, would be as futile as to attempt to displace through legislation railroads by stage coaches and steamships by sailing-vessels.

* "It was from this source that Germany proposed to help herself before it was too late, and thereby array herself in the rank of commercial states which, having large transactions, chose gold, not merely as the most stable in value of the two metals, but as the best medium of exchange for large payments."—Professor Laughlin, *History of Bimetallism in the United States*, p. 135.

AMERICAN CINQUE-FOILS.

By GRANT ALLEN.

YOUR American cinque-foils are to me a deeply interesting set of plants. Excuse, I beg of you, dear Mr. Reader, this abrupt beginning. I love a *causerie:* I love to button-hole my audience, as it were, and, sitting down with it mentally on a bowlder in the meadow, to discuss the matter in hand with it *tête-à-tête*, as if we two were old friends, which I trust, after all, may be really the truth with the public of "The Popular Science Monthly" on the present occasion. For, indeed, a recent visit to America has made me realize you all far better than I ever did before; it has made me feel your individuality as I never hitherto felt it; and it has also renewed with me the acquaintance of many dear old floral favorites whose faces I had not seen in earnest for many a long and weary year. Among them, the cinque-foils or potentillas are, it is true, but a feeble folk; very different from the glorious orange lilies, and trilliums, and Solomon's-seals, whose bulbs and tubers I have brought home with me to beautify a little out-of-the-way Surrey garden; but still in their own humble fashion most interesting plants, from the implications as to their past history and transformations legibly written by the hand of Nature upon their very faces. I propose, therefore (having got you now fairly button-holed), to discourse somewhat concerning the American potentillas themselves, as well as concerning certain of their near and dear relations not included in the same genus by the artificial and unwise arrangements of our existing botany.

The first potentilla I found in America was by chance the very one that ought naturally to head the tribe in any systematic work, because it is the one which more than any other seems to preserve in the greatest simplicity the original traits of the prime ancestor. And when we consider that from this ancestor are also descended (in all likelihood) the plum, the peach, the cherry, the almond, the apple, the pear, the strawberry, the raspberry, the rose, and the hawthorn, it must immediately be apparent to the meanest understanding that the plant in question deserves the greatest consideration at our hands as the founder of a large and important family. Nevertheless, this rather scrubby weed (*Potentilla Norwegica*) with its yellow flowers and hairy stem, much resembles the founders of many other distinguished families in being personally mean, sordid, and inconspicuous. But in spite of its meanness, the Norway potentilla shows many signs of its high respectability as the representative of the elder branch of the family in the direct line. To begin with, its blossoms are a shabby yellow; and shabby yellow I take to have been the original color in every instance of the earliest petals of insect-fertilized flowers. Then, again, it is an annual weed, and herbaceous annuals were doubtless the earliest form of all vegetation all the world over. Once more, the leaves are divided into three leaflets; and this type I take from its frequent recurrence not only among the potentillas themselves, but in the strawberries, the lady's-mantle, the simpler brambles, and many other species as well, to have been the original type of foliage for the entire rose family. Finally, certain minute technical characters in the stipules and the styles, with which I need not trouble you at the present moment, lead to the conviction that we have here to deal to some extent with a fair representative of the old ancestral potentilla form.

The Norway potentilla, however, is distinctly weedy—that is to say, it is one of those unpleasant, dusty-looking plants which loiter about on the precincts of the road-sides and in the waste purlieus of human cultivation. It attests its weediness by its bristly hairs, intended doubtless to repel insects and to make it unpalatable to cattle and horses. As its name implies, it is an Old-World form as well as a native-born American citizen; it is, in fact, a member of that ancient circumpolar pre-glacial flora which was driven down from the once mild and genial Arctic regions by the vast ice-sheet of the Glacial epoch to occupy the plain-lands of either hemisphere in these our chilly and degenerate modern summers. In Europe, however, it remains distinctly a more northern type than with you in America, where it spreads as far south as the Virginia hills.

On the Alpine tops of the White Mountains I was lucky enough to light upon another member of the potentilla group, not far removed in essentials from the Norwegian weed, but infinitely prettier, more delicate, and in a word less weedy all round. This is the plant which Asa Gray identifies with our European *Potentilla frigida* of the Swiss Alps; and I, who have a pious horror of unnecessary splitting and renaming and tinkering, have not the slightest objection to the identification in any way. But it is worth while to notice, what I often observed of almost every American species said to be identical with those of Europe, that the two plants are not absolutely the same: the time that has elapsed since the Great Ice age effectually severed the two continents has sufficed to produce distinct differences in nearly every kind of plant or animal. The flowers in the American specimens are smaller than in the Swiss, and the stems when full-grown are far less hairy.

Potentilla frigida exhibits all the common peculiarities of high Alpine or Arctic plants. It is a dwarf form, not one fifth the size of the Norway species; it is tufted thickly on its low stems, and it has that matted, close, creeping habit which I have already pointed out in this "Monthly" as the distinctive feature of the glacial flora. It sticks still to the three original leaflets, but its flowers, as is common in mountain types, are far larger and handsomer than those of the wayside weed with which we started our examination of the group. This Old-World form, however, occurs nowhere in the United States except here on the topmost summits of the White Mountains, and even there it lingers on in scanty numbers, rapidly diminished by the growing warmth and the incursions of botanists. I took but a tiny spray for my own specimen, from a spot not far from Tuckerman's Ravine, and left the remainder of the plant I found there still growing. It would be a pity if these last survivors of the Glacial epoch, pushed up onto these chilly heights by the secular summer of our own day, should be exterminated by the hands of those who above all others are bound by natural piety to preserve and protect them.

All over Canada and the Northern States there grows a third and very common potentilla, the cinque-foil or "five-finger" of popular botany (*P. Canadensis*), a pretty, prostrate, creeping weed, with golden-yellow flowers springing close to the ground, and five leaflets instead of three to each leaf. Ever since the days of Linnæus this plant has been considered distinct from the common European cinque-foil (*P. reptans*), and the differences are certainly sufficient to justify their division as separate species, as systematic botany goes nowadays. Nevertheless, it is quite clear that we have here merely to deal with the American descendants of the same old circumpolar plant. No European naturalist who saw the Canadian cinque-foil for the first time would ever take it for a distinct type; if he found it growing in an English meadow, he would certainly pass it by unnoticed as the familiar cinque-foil of our eastern hemisphere. The differences can only be observed when you look closely into the plant, and they are all of easy adaptive character. In fact, we have here just the same tendency as that which we noticed in the mountain species, only carried, perhaps, one step farther. In that instance, the differences were only sufficient for sytematic botanists to rank the plant as a mere variety; in this case they are sufficient to give it the dignity of a distinct species. But at bottom nobody knows what is a variety and what a species, and it is a mere matter of individual judgment whether a particular form should be regarded as one or the other. It varies "according to the taste and fancy of the speller." Oakes considered the White Mountain potentilla a distinct American species, different from the Alpine kind in Europe, and christened it, accordingly, *P. Robbinsiana*, after the first person who discovered it on these chilly hill-tops. Asa Gray regards it rather as a mere variety, though he hesitates as to whether it comes nearer to the *P. frigida* of the Alps, or to the dwarf form known as *P. minima* (itself a very ill-marked species). It is always so when you come to compare the plants or animals over a large area. However distinct they may seem in particular localities, they shade off into one another by such imperceptible degrees at distant points that the task of drawing hard-and-fast lines, so lightly undertaken by the systematic biologist, becomes at last absolutely impossible.

This very Canadian cinque-foil, for example, runs into two extreme forms, which have each been considered by confirmed "splitters" as distinct species. The first (*P. sarmentosa*, of Muhlenberg) grows for the most part on very dry soil, and like most plants of arid situations runs largely to pronounced hairiness; for it is a general rule that water-haunting kinds are smooth and glabrous, while dry or desert types are intensely hirsute (the reason for this wide distinction, though well known, would carry us too far away, this morning, from our main subject). The second form, erected by Michaux into a separate species (*P. simplex*) but reduced to subordinate rank as a variety by Torrey and Gray, belongs to moister soil or to deep meadows, where the lush grass prevents evaporation; and this type grows less hairy and greener, and attains a larger and more luxuriant stature. The two forms differ also in other ways, strictly dependent upon their differences of locality. *Sarmentosa*, the dry type, creeps squat upon the ground, as if to avoid the sun, and sends out long, rooting runners in every direction after the fashion of the strawberry-vine; whereas, *simplex*, the moister kind, has ascending stems, which rise in competition among the grasses around them, seldom if ever creep, and never produce summer runners. Again, *sarmentosa* begins to blossom early, and ends early—April to July in the latitude of New York; while *simplex* comes and stops a month or so later at either end—May to September in the same district. In other words, the dry-type flowers early in spring on its basking banks, but retires from the scorching heat of your American summer; while the moist type begins later in its shady habitat, but is less affected by the droughts of August.

Curiously enough, our common European cinque-foil (*P. reptans*), the exact analogue of your American plant, and fellow-descendant of the self-same pre-glacial ancestor, has also two well-marked forms usually considered as distinct species, but merging into one another by imperceptible gradations. The parent-type (*reptans* proper) grows in rich pastures or meadows, and answers best to your variety *simplex*, though it sends out long, creeping stems which root every now and again at the nodes; it has five large petals to each blossom, and the flowers are identical with those of the Canadian cinque-foil. But on open moors, heaths, and dry places, we have a smaller, closer, and more creeping form, the tormentil (*P. tormentilla*); it is silky-hairy, like your own *sarmentosa*, and its upper leaves have often only three leaflets instead of five, thus reverting to the ancestral type of foliage, when the plant was rather a tre-foil than a cinque-foil. But oddest of all, the small flowers have only four petals, arranged like a Maltese cross; whereas all their congeners have their full complement of five, in accordance with the old central plan of the entire rose family. Still, the first flower of all on each stem, produced when the plant is in its vigorous youth, has occasionally five petals; a reversionary fact of great interest. The tormentil has also an intermediate variety of its own (*Tormentilla reptans* of the hair-splitters), which sometimes creeps like the true cinque-foil, and frequently breaks out into five-petaled blossoms. Even Mr. Bentham, that minute and conservative botanist, admits that "intermediate forms" sometimes occur which can not probably be referred to either species.

And yet, though the tormentil and the cinque-foil are thus intimately connected with one another, by imperceptible gradations, so great is the love of petty distinctions in the human breast, that Linnæus actually erected this slight, four-petaled variety, not only into a distinct species, but even into a separate genus (*Tormentilla*).

Let us return, however, to our immediate subject, the American potentillas. The next species recognized by Asa Gray is the silvery cinque-foil (*P. argentea*), a pretty little plant, with small, bright-yellow flowers, confined, for the most part, to very dry, barren, or sandy spots, and with thin, wiry, almost woody stems. It is remarkable for the soft, white, silvery down, that clothes the under side of the five-leaved foliage. The use of this down I do not know, though I suspect it to be a protection from some caterpillar or other insect, which attacks leaves on their under surface. At any rate, it is an exaggeration of the usual downiness of dry-soil species. The silvery cinque-foil is common to Europe and America, and I do not notice any perceptible difference between my English and Canadian specimens. It seems, in fact, to be one of the very few plants which have not altered to any recognizable degree on either side of the Atlantic since the end of the great Glacial epoch. As a proof, however, of the narrow way in which this dry-soil species is restricted and limited to the very sandiest or most barren situations, I may mention that it grows on two spots, and two spots only, within reach of my own home here in Surrey, England. Both these spots are knolls of a peculiarly soft and friable sandstone, into which the rain sinks immediately; and they are the only two bits of that particular formation (a subdivision of the Folkestone sands) to be found anywhere in the neighborhood.

I was shown, at Kingston, Canada, a specimen of another more weedy potentilla (*P. paradoxa*), which has hardly, as yet, made good its place in the Eastern States, but which, nevertheless, possesses a certain interest for naturalists of the Atlantic shore, as a member of the flora by which before long they are almost sure to be overrun. The species belongs to the western half of the continent, but it is already well established as an immigrant along the banks of the Ohio and the Mississippi, and it has been observed near Oneida, and elsewhere on the shores of Lake Ontario. My own specimen was gathered on a common at Kingston, where it seemed to have established itself in full vigor. Now the interest of this species centers in the fact that until lately the weeds of the Eastern States and Canada were almost entirely of European origin; they were the cosmopolitan pests of civilization, which have followed agriculture from Western Asia along the Mediterranean to the shores of the Atlantic, and, crossing the ocean with seed-corn and fodder crops, have clogged the steps of the intrusive white man through all his colonies and settlements elsewhere. These cosmopolitan weeds succeeded in America to the soil once covered by forest-trees, whose indigenous undergrowth could not stand the garish sunlight of the open clearings. But nowadays, the weedier types of the Western prairie-belt are moving eastward, as farms move west; and being accustomed by nature to open plains, they will probably, in many cases, succeed in establishing themselves side by side with the older plagues of the long-suffering farmer. *Potentilla paradoxa* is one of the first crop of these weedy immigrants, and its appearance already on the shores of Lake Ontario is the signal for its future advance in a formed phalanx against the tilled fields of New York and New England.

This Western immigrant departs widely in one respect from the type of all the potentillas we have yet considered, and that is in the arrangement of its five, seven, or nine leaflets. In the true cinquefoils, and all their like, the leaflets are arranged, as we say, palmately —that is to say, all start together, like the lobes of a horse-chestnut leaf, from one point. In the *P. paradoxa* they are arranged pinnately —that is to say, they start in opposite pairs or singly, from a common midrib, like the barbs of a feather or the leaflets of a locust-leaf. The same arrangement, a more convenient one for long leaves, reappears in *P. Pennsylvanica*, which (in spite of the name incorrectly bestowed upon it by Linnæus) is a Northwestern species. But as I have not seen this last-named plant in the living state, and as I do not like to write about what I have only examined in a dried-up herbarium (a bad habit of the old-fashioned, purely structural botanists), I will say no more at present about it.

On the rocky hills of the North and West there occurs in July a rather pretty, half-shrub-like potentilla (*P. arguta*), which presents several other interesting peculiarities. This plant has brownish, hairy stems, covered with a viscid, clammy exudation, something like that which covers the young branches and buds of the clammy rose acacia (*Robinia viscosa*). As I observed that insects are often caught in this clammy secretion, exactly as in the case of the common catchflies (*Silene noctiflora Virginica, regia*, etc.), I have not the least doubt that the potentilla eats and digests the creatures it entraps, in order to supply it with nitrogenous material for its own pollen, ovules, and seeds. This is the more probable, as the clamminess increases near the flower-buds and blossoms, and is scarcely at all noticeable near the base of the stem. How the potentilla digests its food I do not know, but long observation has fully convinced me that whenever a plant has viscid, glandular hairs or secretions upon its penduncles, pedicels, calyx, and flower-buds, it is invariably an insect-catcher, and an insect-eater too. The flowers are the part that require the most nitrogenous food, and near the flowers the nitrogen-catchers are situated.

Another peculiarity of *P. arguta* lies in its flowers, which are clustered in large and conspicuous masses, and have petals that vary from pale yellow to primrose or almost white. This is a very interesting fact, because the native color of the potentillas is yellow; but the mountain species, and many other kinds, have varied to snow-white blossoms; and here we get a plant, as it were, in the intermediate or undecided stage between the two colors. Notice, too, that *P. arguta* is an herb of the rocky hill-sides, and therefore half-way toward becoming a mountain species.

Now, on the summit of Mount Willard, just above the Notch of the White Mountains, I found another very beautiful member of this pretty group, the three-toothed cinque-foil (*P. tridentata*). This is one of your most northerly and mountain-loving potentillas, unknown in Europe, inhabiting the coast of New England from Cape Cod northward, and the mountain-tops of the great chains, from the Alleghanies to the Maine ranges, as well as in Canada, Labrador, and the extreme north of the continent. The three-toothed cinque-foil carries a step farther the same characteristic, for its flowers are pure white, as so often happens with mountain blossoms. Just in the same way, while almost all lowland buttercups are golden yellow, some of the Alpine buttercups are white as milk, and among these very potentillas there are a few lovely snow-white mountain species in Europe and Asia. One beautiful kind that I gathered on the Maritime Alps at Mentone (*P. saxifraga*) has a blossom as delicately mountainous in type as the saxifrages themselves, from which it takes its scientific name.

Of course, I don't for a moment mean it to be understood that I think *P. tridentata* is directly derived from *P. arguta*, or that the latter species is now on its way to merge into the former. My Mount Willard plant has palmate leaves of only three leaflets, while the common *P. arguta* of the northern hill-sides has pinnate leaves of from three to nine cut-edged divisions; and in many other technical points they differ widely from one another. All I mean to suggest is merely that the yellowish-white *P. arguta* is now just passing through a stage which the ancestors of *P. tridentata* must have passed through long ago. On the whole, to put it briefly, the potentillas are a yellow lot; but a few advanced members of the race are white; and still fewer, like the ornamental *P. nepalensis* and *P. atropurpurea* of our gardens, are crimson, scarlet, or bright red. So far as I know, no potentilla is ever blue, which is the highest level of floral coloration.

The three-toothed cinque-foil has an almost shrubby and woody root-stock, and displays a tendency to assume the character of a true shrub. But its northern habitat and mountain manners keep it low and tufted, after the common fashion of upland vegetation. There is another of its kind, however (*P. fruticosa*), which really grows into a regular shrub, with many branches, terminated by large trusses of bright-yellow flowers. Asa Gray says this plant is "common northward" in wet ground, but I was not lucky enough to hit upon it during my visit to America. However, I have seen living specimens from Teesdale in England, and from them I perceive that, in general habit, the plant greatly approaches the rock-roses (*Helianthemum*), which grow in very similar situations. The leaflets of the shrubby potentilla, long, narrow, and silky beneath, resemble, at first glance, the leaves of the rock-roses, thus showing how similar conditions tend everywhere to produce similar results, even when starting from the most unlike organic forms to begin with.

One other potentilla, the goose-weed or silver-weed (*P. anserina*), I must needs mention for form's sake, though I have nothing special to say about it. It is a creeping species, growing close to the ground, with long pinnate and prostrate leaves, silvery white below, with silky down. Both in Europe and America it is very common as a road-side weed, and in moist ditches; but with us it is a weedier and scurvier plant than with you—evidently a sufferer from our long civilization. In America it grows mostly by river-banks and in brackish marshes; in Europe, it belongs rather to waste places and stony pastures than to streams or mud-banks. Few temperate plants, however, have a wider distribution. It is a circumpolar weed in both great continents, extending through Russia and Siberia to Alaska and British America, and it reappears once more, under like conditions, in the southern hemisphere. Nothing kills it out, and it will bear both inundation and trampling under foot to a greater degree than any other plant of equal importance.

The handsomest of your American potentillas, however, is the marsh five-finger (*P. comarum* or *palustris*), a very bold and elegant water-side plant, bluish-green in stem and leaves, and with loose corymbs of exceedingly pretty though dingy flowers. The calyx, inside, is lurid-red, and the large petals are tinged with a gloomy and peculiar purple. This fine ornamental plant loves cool northern bogs and marshes, being common in Canada and in the Scotch Highlands. But what gives it to me the deepest interest is its exact resemblance in hue and general aspect to a purple avens (*Geum rivale*), also common to either hemisphere. Both are plants of the cold swamps and peaty places; both depend for fertilization upon water-side insects; both have lurid-reddish calyxes, and both have large and dingy purplish petals. The inference seems to me irresistible that the color has been evolved in both cases by the special tastes of the upland water-creatures to whose aid both owe the impregnation of their ovules. Indeed, it is often easy thus to classify flowers functionally by their color and the tastes of the particular insects that habitually visit them. In Europe, at least, I believe the particular insect in this case to be *Rhingia rostrata*, which I have observed in great abundance upon both flowers. American naturalists, please verify, or look out for, the corresponding American species.

On the Alpine summits of the White Mountains, and far to the north again in the Labrador region, there grows abundantly a little matted mountain plant, not recognized by the scientific world at large as a potentilla at all, and known by the name of *Sibbaldia procumbens*. But you may call the plant whatever you like without altering the undeniable fact that it is in all essentials a dwarfed and depressed mountain potentilla, with the flowers so reduced by chilly conditions that very few stamens or carpels remain, and with the usual dense, spreading, tufty habit common to all Alpine vegetation. It is clearly descended from a high hill-side potentilla not unlike the white *P. tridentata* of Mount Willard aforesaid (only with yellow flowers), for it has the same type of tre-foil leaves, with each leaflet three-toothed at the end, and the same general aspect and habit. Both plants, I do not doubt, are common descendants of a single antique Arctic ancestor. But little *Sibbaldia* has grown so very small and degraded in time that its flowers have dwindled away almost to nothing; the green calyx forms its most conspicuous part; the pale-yellowish petals are very tiny, and in many cases are entirely wanting. In the States *Sibbaldia* is confined to the higher summits of the White Mountains; but in the Scotch Highlands, as in the far north of British America, it often constitutes for miles together the main element of the low and matted mountain greensward.

Last among your American potentillas I may mention the wild strawberries. Though these at first sight seem somewhat different from the rest of the group, I have not the slightest hesitation in saying that to the evolutionary botanist they can not but appear as closely related species of one and the same natural genus. For the strawberries are only potentillas in which the receptacle of the fruit, instead of remaining hard and dry, swells out into a colored and pulpy mass, attractive to birds, who thus aid in dispersing the tiny "achenes" or nutlets (commonly, and for all practical purposes correctly enough, described as seeds). To us in Europe, the essential identity of the two types is made all the more evident, because we happen to possess a little three-leafleted white potentilla (*P. fragariastrum*) so exactly like a wild-strawberry vine in foliage and flower that few save botanists or close observers of Nature ever adequately distinguish between them. This white potentilla is, in fact, a strawberry in everything essential except the fruit; and the succulence of the fruit (or rather receptacle) is after all a matter of comparatively little importance except to the men and birds who eat it. I am fully convinced that if the strawberry had not been an edible berry it would always have been classed merely as a potentilla, and considered as very closely analogous to the *P. fragariastrum* or "barren strawberry" of Northern Europe. It is hardly more, indeed, than a mere variety.

You have in America two slightly divergent forms of the wild strawberry, erected into species by American botanists, for small differences in the appearance of the berry. Had these differences occurred in any other than an edible fruit they would, I am sure, hardly have been noticed: occurring there, they have been suffered to assume a factitious importance in the eyes of systematizers. One of these varieties (*Fragaria vesca*), which grows in fields and open places, is the common wild strawberry of Europe; but it bears somewhat larger berries with you than with us, and has a somewhat more erect and noble habit. Apparently it is proud of its American citizenship. It is distinguished by having the nutlets merely superficial on the outside of the berry, not sunk in pits, as in the second variety. This last-named form (*F. Virginiana* or *F. Canadensis*) is peculiar to America, and differs from the European type in the constricted or bottle-shaped neck of the berry, and in the deep depressions for the nutlets, the ribs between which accordingly give the fruit a distinctly pitted or spiny appearance. It is a woodland plant, native to your forests, and far more forestine in aspect and habit than our English vine. In flavor, also, it differs distinctly, and your cultivated Virginia scarlets are its final product in the gardeners' hands. The Western variety (*Illinoensis*), according to Gray, gives origin to Hovey's seedling, the Boston pine, and many other cultivated strains. No European strawberry can at all equal these native American fruits in delicacy of flavor.

There is a third species of strawberry, undoubtedly distinct, admitted by Gray as a naturalized American, which possesses for me a peculiar interest. This is the *Fragaria Indica*, or *Duchesnea fragarioides*, a Himalayan species, established in copses round Philadelphia and at various places in the Southern States. Some years ago a plant of this curious species was sent to me in a box for identification: I set it out, on the off chance of its living, in my garden at Dorking; and it now overruns the whole place, so that I have had abundant opportunities of observing its growth and development to my heart's content. I am certain that *F. Indica* is not a true strawberry at all; or, in other words, that it is not a common descendant with the other strawberries of any original white-flowered potentilla ancestor, but an independent development of the succulent habit all by itself. It has yellow blossoms, a very different calyx, and a most insipid, pulpy fruit. I have not the slightest doubt that this species has been developed from a yellow Indian potentilla, just as our strawberries have been developed from a white European potentilla, by the unconscious agency of birds in dispersing the nutlets. All that the two plants have in common (beyond their undoubted generic potentilla type) is the mere fact of a succulent receptacle, which might just as easily occur independently in the one case as in the other. If I had to remodel the genus *Potentilla* on my own account, I would certainly put the common strawberry into the same division as the white-flowered European *P. fragarioides*, while I would put the Indian species into the same division with the yellow-flowered *P. frigida* of your Mount Washington range.

THE RISE OF THE GRANGER MOVEMENT.

By CHARLES W. PIERSON.

SOME wise men of the press are saying that the Knights of Labor are like the Grangers. As the exact points of resemblance are not stated, the assertion serves merely to call up a recollection of the unique secret society, which, a dozen years ago, seemed far more powerful than ever the Knights of Labor were. The Grange still lives, but its glory is departed, and its history is recorded only in the distorted statements of partisans and of misinformed review-writers.

In the latter part of 1868 certain Minnesota farmers received a printed sheet which began as follows: "In response to numerous inquiries in regard to our order, this circular is issued. The order was organized by a number of distinguished agriculturists of various States of the Union at Washington in December, 1867, and since then has met with most encouraging success, giving assurances that it will soon become one of the most useful and powerful organizations in the United States. Its grand object is not only general improvement in husbandry, but to increase the general happiness, wealth, and prosperity of the country." As an aid in accomplishing its author's design, this circular was certainly a success. As a statement of truth it was a conspicuous failure. Instead of having "met with most encouraging success," the order had scarcely been heard of; while the "distinguished agriculturists" who had "organized" it comprised one fruit-grower and six Government clerks, equally distributed among the Post-Office, Treasury, and Agricultural Departments. Of these seven Immortal Founders, as enthusiastic Grangers were calling them a few years later, six are living. Nevertheless, it is difficult to determine just how much of the plan and its execution was due to each. The truth seems to be about as follows: In 1866 one O. H. Kelley, a clerk in the Agricultural Department, was sent by the Commissioner of Agriculture on a tour of inspection through the Southern States. Impressed with the demoralization of the farming population, he hit upon the idea of organization for social and educational purposes, as a means for these people to better their condition. An ardent Mason, he naturally thought of an organization similar to the Masonic, in whose ritual, secrecy, and fraternity he saw the secret of that permanence which all agricultural societies had failed to attain. A niece in Boston, to whom he first mentioned the idea, recommended that women be given membership, thus originating an important feature.

On returning to Washington, Kelley took the other six immortals into his confidence, and the seven set about developing the plan and constructing a ritual. It would be a long story to tell how, by two years' labor in the intervals of their regular work, they constructed a constitution providing for a national, State, county, and district organization, and a ritual with seven degrees; how the names—Patrons of Husbandry for the body in general and Grangers for the subordinate chapters—were finally hit upon, the latter being taken, not on account of its etymological meaning (Latin *granum*), but from the name of a recent novel. Suffice it to say that on December 4, 1867, a day still celebrated as the birthday of the order, the seven assembled, and, with an assurance almost sublime, solemnly organized themselves as the "National Grange of the Patrons of Husbandry." There was none to dispute the title, and they enjoyed it alone for the next five years. It is hard to tell just what were the expectations of these men. Kelley has been called everything from an unselfish philanthropist to a scheming adventurer. One can not but admire the pluck with which he persevered through great discouragements, and the unselfish spirit in which he and his fellow-workers surrendered control of the movement when it had become a power in the land. Their first step was to organize a mock Grange among their fellow-clerks and their wives, to experiment with the ritual. The experiment proving satisfactory, Kelley resigned his clerkship and started out to proclaim the Grange to the world, armed only with a few dollars and a sort of introductory letter from the other six to mankind at large.

He was not a success as a lecturer. Moreover, he made the mistake of laboring in the larger towns, instead of in the country. The four or five Granges that he coaxed into life at once proceeded to die, and he finally reached Minnesota penniless, but not discouraged. Even while the six at Washington were becoming faint-hearted, and writing to him that the landlady was pressing them grievously for hall-rent, and that it would be wise to give up the whole business, he could issue the circular with which I began, dilating upon the success of the order and the distinguished agriculturists at Washington who founded it. At his home, near Itasca, he worked on furiously, now dodging a creditor, again obliged to postpone answering letters for want of means to buy postage-stamps, till finally signs of success began to appear. He had organized a few Granges in Minnesota, and was able to detect a growing interest in other States. The prime necessity now was to encourage this feeble beginning, and by all means to keep it under the delusion that it was part of a powerful national organization. To this end every cent that could be earned or borrowed was used in distributing photographs of the founders, along with a mass of circulars and documents purporting to come from the national office at Washington. Every important question was ostensibly referred by Kelley to the Executive Committee at the same place, and the decisions and power of this mythical body were held in great awe by the Patrons. But other men were becoming interested and going to work. In Minnesota they were able to organize a State Grange, having mustered the fifteen district Granges required by the constitution. Two years later the State Grange of Iowa was organized, and its Worthy Master crossed the country to attend what the founders were pleased to call the "Fifth Annual Session of the National Grange." He was the first member of the order to meet with the seven. What he thought on ascertaining the real state of things is not recorded. However, he did not give up the work, and later he became Worthy Master of the National Grange. The order kept growing. At the sixth annual session, held at Georgetown in January, 1873, there were delegates from eleven States, and four women were present; 1,074 Granges had been organized during the year. The founders now gave up their offices, not even reserving the right to vote, and delivered over the results of six years' labor to their successors. For the first time, the greatest of farmers' societies was in the hands of farmers!

The next two years were years of astounding growth—a growth almost unparalleled in the history of secret organizations, and resembling that of the Know-Nothings twenty years before. At the end of 1872 about 1,300 Granges had been organized. In the year 1873, 8,668 more were added; and in 1874, 11,941, making a total of almost 22,000, with an average membership of forty. Some idea of the magnitude of these figures may be gained from the fact that the whole number of lodges of Masons and Odd-Fellows in the world is estimated at about 20,000. The order was represented in every State except Rhode Island (which has never found room for it). It had been established in the Indian Territory, whence it appealed for help to the National Grange because the governor of the Chickasaw nation looked on it with suspicion, and had ordered all Grangers out of the Chickasaw country. It had taken root in Canada, where, a few years later, there were 860 subordinate Granges. One deputy introduced it into England; others were laboring in France and Germany; and inquiries and invitations were coming even from Australia and Tasmania.

Grange treasuries were overflowing. In 1873 and 1874 the dues to the National Grange alone, according to the official statement, amounted to $348,532.20. The press was discussing the new order with alarm. Legislative committees were scurrying about the country to see what could be done for the farmer. In the words of the New York "Nation," "the farmer was the spoiled child of our politics." The House of Representatives at Washington was overawed at the new power that was apparently rising in politics, and those who claimed, for the most part falsely, to represent the movement enjoyed an astonishing influence. Among other legislation secured by these men, one bill was rushed through for printing and distributing to the farmers certain agricultural documents, at an expense of $500,000! W. W. Phelps opposed it, only to be bitterly attacked on the score of sympathy with monopolists and lack of sympathy with farmers. One fervid orator from Kansas went over his whole record for proofs of this, and alleged many damaging facts—among them that he was rich, that he was interested in banks and railroads, and that he had been graduated with honor from Yale College. "These Grangers," exclaimed the orator, "mean business; . . . they are chosen to be the *sovereigns* of the mightiest republic of earth." Various cities strove for the honor of having the National Grange offices located within their limits, one offering to give a splendid building, another, to furnish necessary office-room and an annuity of $5,000 for five years, but the Grange was rich and independent in those days. At the seventh annual session held at St. Louis in 1874, a declaration of purposes was adopted which still remains the official statement. I can quote but fragments of this creditable document: "We shall endeavor . . . to enhance the comforts and attractions of our homes, and strengthen our attachment to our pursuits; to foster co-operation; . . . to diversify our crops; to condense the weight of our exports, selling less in the bushel and more on hoof and in fleece; to discountenance the credit system, the mortgage system, the fashion system, and every other system tending to prodigality and bankruptcy. We propose meeting together, buying together, selling together. We wage no aggressive warfare against any other interests whatever; . . . we hold that transportation companies are necessary to our success, that their interests are intimately connected with our interests, and that harmonious action is mutually advantageous. *We are not enemies of railroads.* In our noble order there is no communism, no agrarianism; we emphatically assert the truth taught in our organic law that the Grange is not a political or party organization. No Grange, if true to its obligations, can discuss political or religious questions, nor call political conventions, nor nominate candidates, nor even discuss their merits in its meetings." It is to be noted that this is 1874, at the height of the "Anti-Railroad" and "Farmers' party" excitement.

The Grange had now reached the zenith of its power. One year later, in the stormy meeting held at Charleston, a measure was passed for the distribution of the surplus revenue of the National Grange, which may be said to mark the beginning of Grange decadence. But a consideration of this decadence may well be postponed for a time.

Any discussion of the causes of the Grange's astonishing growth has been deferred to this point, in order that they may be considered in connection with the railroad legislation of the early seventies, with which the Grange, to most minds, is so entangled. The spirit of enterprise following the war found vent in developing the resources of the upper Mississippi Valley. Emigration from Europe thither increased greatly after the close of hostilities, and the tide was swelled by men turned adrift in the disbanding of the armies. The cry was for railroads to open the country, and the speculative spirit, induced by an inflated currency, was quick to second it. Land-grants of enormous extent were made by the General and State governments, and Western municipalities vied with each other in bonding themselves to offer inducements to railroad-building. In the years 1865–'71, $500,-000,000 was invested in Western railroads. D. C. Cloud, in his "Monopolies and the People," makes the statement that "one acre out of every eight and a half of the entire area of Iowa has been given away to railroad corporations. . . . There were land-grants, subsidies, bonds, subscriptions, and taxes to the amount of five per cent of our entire valuation in one year." Every farmer wanted a railroad, and every one with any pretense to economic knowledge wanted two, to keep down charges by competition! Railroads and population reacted on each other. The consequence was, that both railroads and population moved too far west, accumulating debt in the inflated currency as they went. There was little traffic for the railroads in anything but grain. So long as the price of this was high, all went well, and they were suffered to go on their reckless way with little remark save a clamor for more competing roads where the pinch of discrimination was felt. But conditions changed. The price of wheat began to show the effect of the enormous increase of production. The demand caused by the Prusso-Austrian and Franco-German wars ceased. The grasshopper became a burden. The farmers, who had gone into debt in flush times, felt the pinch of an appreciating currency. A villainous tariff, increasing the cost of transportation and of everything they bought, conspired with the rest to produce unavoidable distress. Add to all this the crisis of 1873, and it is not strange that there was a "Farmers' Movement." "Organize!" was the universal cry, and there were as many reasons for it, in the farmer's mind, as he had needs and grievances, fancied or real, and these were legion. Owing to the change in economic conditions, wheat could no longer pay transportation charges and be profitable. According to the report of the Senate Committee on Transportation to the Seaboard, the average price of wheat in Chicago fell thirty-three cents from 1868–'72, while the charge for transportation to the East fell but nine cents. The farmer was forced to feed his grain to his cattle or use it for fuel. In this state of things the railroad loomed up before him as the only obstacle between himself and his hungry Eastern brother, whose needs he was anxious to supply—for a fair compensation. A toll for transportation exceeding the price he received seemed *a priori* a monstrous extortion. To aggravate matters, the railroads were run with unparalleled short-sightedness. The term "railroad official" was a synonym for insolence. There had been great corruption in the building of many of the roads, and such imperfectly comprehended terms as "Crédit

Mobilier," "watered stock," and "Wall Street speculation," were in everybody's mouth. Most of the stock was owned in the East and in Europe, and the expression "absentee ownership" began to arouse somewhat the same feeling as in Ireland. The "Nation" pleaded for the widows and orphans who were kept from want only by their railroad-stock, but the farmer replied that the stock was in the hands of such orphans as Commodore Vanderbilt and Jay Gould, who could look out for themselves. Add the fact that the railroads felt the hard times as much as the farmers; that for very self-preservation the traffic at competing points was so furiously fought for as to make rates ruinously low, while each road extorted all it could squeeze where there was no competition, and it will not seem strange that the "Farmers' Movement" developed, on one side, into a political organization to fight railroads. But this was not the Grange. A misconception exists on this point. In everything published on the subject, the anti-railroad movement is called the Granger movement; the resulting legislation, the Granger legislation; the cases that arose, the Granger cases. It must be granted that the same farmers often were engaged in both movements, and that certain subordinate parts of the Grange did sometimes disobey their organic law so far as to engage as bodies in the agitation, chiefly by memorializing Legislatures. It was impossible to control completely the rank and file of such a vast order. But, with these reservations, the Grange, as an organization, took no part in the anti-railroad agitation. The two were not cause and effect, but parallel effects of the same general causes. In the way of proof the "Declaration of Purposes" of 1874 has already been quoted, to the effect that the Grange is not hostile to railroads, and that all political action and discussion is totally excluded. The published proceedings of the National Grange show the same thing. In 1874 the executive committee reported: "Unfortunately for the order, the impression prevails to some extent that its chief mission is to fight railroads." In 1875 a resolution from Texas favoring railroad legislation was suppressed. In 1873 the Master of the Minnesota State Grange, being informed that certain Granges in his jurisdiction had appointed delegates to a State anti-railroad convention, ordered the offending Granges to recall their delegates. Congressman D. W. Aiken, of South Carolina, long a member of the National Executive Committee, said in an address four years ago: "Frequently had the Grange to bear the odium of other men's sins. . . . For instance, there existed in Illinois and Wisconsin, and other sections of the Northwest, agricultural clubs whose province seemed to be to wage war against transportation companies. Anathemas were hurled upon the Grange for making this attack, whereas every Patron of Husbandry knew that the Grange as such was not a participant in the fight from beginning to end." It may seem surprising that such an error should have arisen, but it is not inexplicable. The newspapers first applied the name "Grangers" to Western farmers in general, and consequently to those fighting railroads. From this it was an easy step to the assertion that the Grange was the fighting organization. There were some exceptions. The "Tribune" sent a special correspondent West, and afterward published a "Farmers' Extra," in which it is expressly recognized that the Grange is not fighting railroads, though some Grangers are. The "Times" published the same discovery with the comment that the general impression on this point was a mistaken one. But the "Nation," which talked loudest of all, and the press in general, made no such distinction. It is not strange that Mr. C. F. Adams and other writers on railroads have followed this leading, as it was of no consequence to them whether the Western agitators were known as "Grangers" or by any other name. The principal difficulty is with those who wrote from the farmers' standpoint. It can only be said that they wrote before the railroad legislation had been given a fair trial, and that they wanted to claim for the order the credit of what looked like a success. Their books, in general, are of a hortatory and prophetic rather than historical character.

From this point of view it may seem foreign to our subject to discuss the railroad agitation further. Its intimate connection with the Granger movement, however, and the causal relation between the two in the public mind, may furnish excuse. In 1867, when the Grange was founded at Washington, most of the Western States were still passing laws to facilitate municipal and other aid to railroads. A few, however, were beginning to take the alarm, and about 1867 six made feeble attempts to check the growing abuses; from Iowa, which merely affirmed the full liability of the railroads as common carriers, to Ohio, where a "Commissioner of Railroads and Telegraph" was provided for. The feeling grew during the next three years. Illinois, for example, passed an act in 1869 providing that "all railroad corporations shall be limited to a just, reasonable, and uniform toll." These facts are mentioned to show—not tangible results, for they were not attained, but the growth of public feeling prior to the adoption of the new State Constitution by Illinois in 1870, which, with the bills immediately following, first awakened the country at large to the fact that something was brewing among the Western farmers. The Constitution of 1870 declares: "Railroads . . . are hereby declared public highways, and the General Assembly shall . . . pass laws establishing reasonable maximum rates. . . . No municipality shall ever become subscriber to the capital stock of any railroad." The attack was followed up in 1871 by an act establishing a system of maxima, and providing for a Board of Commissioners to put to each company forty-one specified questions and as many more as their ingenuity might devise. The railroads, relying on the Dartmouth College case, declared the law unconstitutional and refused to obey it. In the suits that arose, Judge Lawrence, of the State Supreme Court, pronounced the fixing of maxima by statute unconstitutional with reference to the new State Constitution, expressing no opinion on the point claimed by the railroads—that this Constitution itself was contrary to the clause in the United States Constitution in regard to impairing the obligation of contracts. Coming up for re-election, Judge Lawrence was defeated, to the astonishment of himself and everybody else, by a combination of farmers. Emboldened by success, the farmers held nominating conventions, and managed to elect several circuit judges, and county tickets in nearly half the counties. A great mass-meeting was held at Springfield during the session of the Legislature in that city, to urge upon it the necessity of a new railroad bill. The Legislature, nothing loath, passed the law of 1873, avoiding the point made by Lawrence against that of 1871 by providing for "reasonable" instead of "maximum" rates, and making it the duty of the commissioners to draw up a schedule of such rates. Provision was made that they be ideally unfit for the task in the following section: "No person shall be appointed who is in any way connected with any railroad company, or who is, directly or indirectly, interested in any stock or bond." It is no wonder that their schedule was as fearfully and wonderfully made as a United States tariff list. The "Nation" called it "a crazy table of rates drawn up by a mob of ignorant and excited politicians." The system had one advantage, however, over a cast-iron set of maxima fixed by statute. It could be modified or made inoperative as the information of the commissioners grew, and this is what was done in Illinois. Early in 1873 the "American Cheap Transportation Company" was organized at the Astor House, and later in the year two other great mass-meetings were held in Illinois. They accomplished only a great waste of pyrotechnic eloquence. Demagogues and sharpers had taken control, and the real movers had quietly dropped out.

In spite of the assertions of Mr. C. F. Adams and others, it can be shown that the Grange was not responsible for the Illinois legislation. When the Constitution of 1870 and the law of 1871 were passed, the Grange had scarcely a foothold in the State. The State Grange was organized in March, 1872. The real organ of agitation was the "State Farmers' Association," whose subordinate lodges were called "Farmers' Clubs." Its president, W. C. Flagg, testified before the Windom committee in 1873 that he was not a Granger, that his organization was an open and political one, while the Grange was secret and non-political, disavowing and preventing, as far as it could, any political action.

By 1874 seven States had passed so-called "Granger" laws, either fixing maxima or providing for a commission to make out a schedule of rates. The Iowa bill, on the former model, devoted twenty-six pages to a classification of freight. But all this was surpassed in Wisconsin. In 1873 there appeared in the State Senate a certain Potter, from Wautoma, Waushara County. It was said that his county did not contain a mile of railroad, and he probably knew as little about railroads as any other man in the Legislature; at least, to believe the contrary would require a very pessimistic view of Wisconsin intelligence. March 11, 1874, the famous "Potter Bill" became a law. Mr. Potter is said to have made it up by calling for suggestions and incorporating those most disadvantageous to the railroads. At any rate, it was bad enough at first, and the railroad interest worked to increase its enormities, hoping to get it into a shape that they could defeat. They were mistaken. The bill passed, and the Governor celebrated some speedy victories in the courts by firing cannon.

Meanwhile cases were before the Supreme Court on the validity of all this legislation. The court recognized the gravity of the question and reserved its decision, affirming the constitutionality of the laws, for more than a year after the test case (Munn *vs.* Illinois) was argued. The gist of the decision is in the following words: "When one devotes his property to a use in which the public has an interest, he, in effect, grants the public an interest in that use, and must submit to be controlled by the public for the common good to the extent of the interest he has thus created." The decisions in this, and the six other "Granger" cases, were pronounced by Chief-Justice Waite, Justices Field and Strong dissenting.

In the courts the farmers were victorious. But, unfortunately, the Supreme Court does not pass upon economic laws, and to these the movement had already succumbed. By the time the cases were decided, in 1876–'77, scarcely one of the statutes in question remained in force. In the second year under the Potter law, no Wisconsin road paid a dividend, and only four paid interest on their bonds. Foreign capitalists refused to invest further in the State. On the recommendation of the Governor, the very men who had passed the law hurriedly repealed it. In the next year Mr. Potter faded out of American politics, and his place in the Senate was filled by another. Most of the other States also beat a precipitate retreat, poorly covered by a faint demonstration against unreasonableness in general.

So the victors were beaten, and bad times made the defeat seem worse than it was. But they claim, and not without reason, to have done lasting good. The attitude of railroad corporations is very different from what it was twelve years ago. More of the old grievances have disappeared than is generally supposed. To this movement we owe the railroad commissions found in so many States. How much they are worth is, of course, a matter for dispute. The power of the railroads to reward or punish is so real and present, while that of the people at large is so indefinite and far away, that it is not strange if the ordinary commissioner inspires about the same terror as does the gingerbread lion. Of late the Grange, forgetting its record, has been claiming the credit for all the good accomplished. It is gravely asserted that a resolution of the National Grange in 1874 caused the appointment of the Windom Committee on Transportation in 1872. In New York, Grangers boast of the Hepburn Commission of 1879, and claim to have defeated a railroad man, C. M. Depew, for the Senate in 1881. And doubtless the Interstate Commerce Bill will be hailed as one more achievement.

NOTE.—The progress and decline of the Granger movement will be considered in a later article.—ED.

THE BOYHOOD OF DARWIN.*

By HIMSELF.

[MY father's autobiographical recollections, given in the present chapter, were written for his children—and written without any thought that they would ever be published. To many this may seem an impossibility; but those who knew my father will understand how it was not only possible but natural. The autobiography bears the heading, "Recollections of the Development of my Mind and Character," and ends with the following note: "August 3, 1876. This sketch of my life was begun about May 28th at Hopedene,* and since then I have written for nearly an hour on most afternoons." It will easily be understood that, in a narrative of a personal and intimate kind, written for his wife and children, passages should occur which must here be omitted; and I have not thought it necessary to indicate where such omissions are made. It has been found necessary to make a few corrections of obvious verbal slips, but the number of such alterations has been kept down to the minimum.—F. D.]

A GERMAN editor having written to me for an account of the development of my mind and character, with some sketch of my autobiography, I have thought that the attempt would amuse me, and might possibly interest my children or their children. I know that it would have interested me greatly to have read even so short and dull a sketch of the mind of my grandfather, written by himself, and what he thought and did, and how he worked. I have attempted to write the following account of myself as if I were a dead man in another world looking back at my own life. Nor have I found this difficult, for life is nearly over with me. I have taken no pains about my style of writing.

I was born at Shrewsbury on February 12, 1809, and my earliest recollection goes back only to when I was a few months over four years old, when we went to near Abergele for sea-bathing, and I recollect some events and places there with some little distinctness.

* From advance sheets of "Life and Letters of Charles Darwin," by his Son, Francis Darwin. New York: D. Appleton & Co.

† Mr. Hensleigh Wedgwood's house in Surrey.

My mother died in July, 1817, when I was a little over eight years old, and it is odd that I can remember hardly anything about her except her death-bed, her black-velvet gown, and her curiously-constructed work-table. In the spring of this same year I was sent to a day-school in Shrewsbury, where I stayed a year. I have been told that I was much slower in learning than my younger sister Catherine, and I believe that I was in many ways a naughty boy.

By the time I went to this day-school* my taste for natural history, and more especially for collecting, was well developed. I tried to make out the names of plants,† and collected all sorts of things—shells, seals, francs, coins, and minerals. The passion for collecting which leads a man to be a systematic naturalist, a virtuoso, or a miser, was very strong in me, and was clearly innate, as none of my sisters or brother ever had this taste.

One little event during this year has fixed itself very firmly in my mind, and I hope that it has done so from my conscience having been afterward sorely troubled by it ; it is curious as showing that apparently I was interested at this early age in the variability of plants ! I told another little boy (I believe it was Leighton, who afterward became a well-known lichenologist and botanist) that I could produce variously-colored polyanthuses and primroses by watering them with certain colored fluids, which was of course a monstrous fable, and had never been tried by me. I may here also confess that as a little boy I was much given to inventing deliberate falsehoods, and this was always done for the sake of causing excitement. For instance, I once gathered much valuable fruit from my father's trees and hid it in the shrubbery, and then ran in breathless haste to spread the news that I had discovered a hoard of stolen fruit.

I must have been a very simple little fellow when I first went to the school. A boy of the name of Garnett took me into a cake-shop one day, and bought some cakes for which he did not pay, as the shopman trusted him. When we came out I asked him why he did not pay for them, and he instantly answered, "Why, do you not know that my uncle left a great sum of money to the town on condition that every

* Kept by Rev. G. Case, minister of the Unitarian Chapel in the High Street. Mrs. Darwin was a Unitarian and attended Mr. Case's chapel, and my father, as a little boy, went there with his elder sisters. But both he and his brother were christened and intended to belong to the Church of England; and after his early boyhood he seems usually to have gone to church and not to Mr. Case's. It appears ("St. James's Gazette," December 15, 1883) that a mural tablet has been erected to his memory in the chapel, which is now known as the "Free Christian Church."

† Rev. W. A. Leighton, who was a schoolfellow of my father's at Mr. Case's school, remembers his bringing a flower to school and saying that his mother had taught him how, by looking at the inside of the blossom, the name of the plant could be discovered. Mr. Leighton goes on, "This greatly roused my attention and curiosity, and I inquired of him repeatedly how this could be done?"—but his lesson was, naturally enough, not transmissible.

tradesman should give whatever was wanted without payment to any one who wore his old hat and moved [it] in a particular manner?" and he then showed me how it was moved. He then went into another shop where he was trusted, and asked for some small article, moving his hat in the proper manner, and of course obtained it without payment. When we came out he said, "Now, if you like to go by yourself into that cake-shop" (how well I remember its exact position,) "I will lend you my hat, and you can get whatever you like if you move the hat on your head properly." I gladly accepted the generous offer, and went in and asked for some cakes, moved the old hat, and was walking out of the shop, when the shopman made a rush at me, so I dropped the cakes and ran for dear life, and was astonished by being greeted by shouts of laughter by my false friend Garnett.

I can say in my own favor that I was as a boy humane, but I owed this entirely to the instruction and example of my sisters. I doubt, indeed, whether humanity is a natural or innate quality. I was very fond of collecting eggs, but I never took more than a single egg out of a bird's nest, except on one single occasion, when I took all, not for their value, but from a sort of bravado.

I had a strong taste for angling, and would sit for any number of hours on the bank of a river or pond watching the float. When at Maer* I was told that I could kill the worms with salt and water, and from that day I never spitted a living worm, though at the expense probably of some loss of success.

Once as a very little boy while at the day-school, or before that time, I acted cruelly, for I beat a puppy, I believe, simply from enjoying the sense of power; but the beating could not have been severe, for the puppy did not howl, of which I feel sure, as the spot was near the house. This act lay heavily on my conscience, as is shown by my remembering the exact spot where the crime was committed. It probably lay all the heavier from my love of dogs being then, and for a long time afterward, a passion. Dogs seem to know this, for I was an adept in robbing their love from their masters.

I remember clearly only one other incident during this year while at Mr. Case's daily school—namely, the burial of a dragoon-soldier; and it is surprising how clearly I can still see the horse with the man's empty boots and carbine suspended to the saddle, and the firing over the grave. This scene deeply stirred whatever poetic fancy there was in me.

In the summer of 1818 I went to Dr. Butler's great school in Shrewsbury, and remained there for seven years till midsummer, 1825, when I was sixteen years old. I boarded at this school, so that I had the great advantage of living the life of a true school-boy; but as the distance was hardly more than a mile to my home, I very often ran there in the longer intervals between the callings over and before locking up

* The house of his uncle, Josiah Wedgwood.

at night. This, I think, was in many ways advantageous to me by keeping up home affections and interests. I remember in the early part of my school-life that I often had to run very quickly to be in time, and from being a fleet runner was generally successful ; but when in doubt I prayed earnestly to God to help me, and I well remember that I attributed my success to the prayers and not to my quick running, and marveled how generally I was aided.

I have heard my father and elder sister say that I had, as a very young boy, a strong taste for long, solitary walks ; but what I thought about I know not. I often became quite absorbed, and once, while returning to school on the summit of the old fortifications round Shrewsbury, which had been converted into a public foot-path with no parapet on one side, I walked off and fell to the ground, but the height was only seven or eight feet. Nevertheless, the number of thoughts which passed through my mind during this very short but sudden and wholly unexpected fall, was astonishing, and seem hardly compatible with what physiologists have, I believe, proved about each thought requiring quite an appreciable amount of time.

Nothing could have been worse for the development of my mind than Dr. Butler's school, as it was strictly classical, nothing else being taught, except a little ancient geography and history. The school as a means of education to me was simply a blank. During my whole life I have been singularly incapable of mastering any language. Especial attention was paid to verse-making, and this I could never do well. I had many friends, and got together a good collection of old verses, which, by patching together, sometimes aided by other boys, I could work into any subject. Much attention was paid to learning by heart the lessons of the previous day ; this I could effect with great facility, learning forty or fifty lines of Virgil or Homer, while I was in morning chapel ; but this exercise was utterly useless, for every verse was forgotten in forty-eight hours. I was not idle, and, with the exception of versification, generally worked conscientiously at my classics, not using cribs. The sole pleasure I ever received from such studies was from some of the odes of Horace, which I admired greatly.

When I left the school I was for my age neither high nor low in it ; and I believe that I was considered by all my masters and by my father as a very ordinary boy, rather below the common standard in intellect. To my deep mortification my father once said to me, "You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all your family." But my father, who was the kindest man I ever knew, and whose memory I love with all my heart, must have been angry and somewhat unjust when he used such words.

Looking back as well as I can at my character during my school-life, the only qualities which at this period promised well for the future were, that I had strong and diversified tastes, much zeal for whatever interested me, and a keen pleasure in understanding any complex subject or thing. I was taught Euclid by a private tutor, and I distinctly remember the intense satisfaction which the clear geometrical proofs gave me. I remember, with equal distinctness, the delight which my uncle gave me (the father of Francis Galton) by explaining the principle of the vernier of a barometer. With respect to diversified tastes, independently of science, I was fond of reading various books, and I used to sit for hours reading the historical plays of Shakespeare, generally in an old window in the thick walls of the school. I read also other poetry, such as Thomson's "Seasons," and the recently published poems of Byron and Scott. I mention this because later in life I wholly lost, to my great regret, all pleasure from poetry of any kind, including Shakespeare. In connection with pleasure from poetry, I may add that in 1822 a vivid delight in scenery was first awakened in my mind, during a riding tour on the borders of Wales, and this has lasted longer than any other æsthetic pleasure.

Early in my school-days a boy had a copy of the "Wonders of the World," which I often read, and disputed with other boys about the veracity of some of the statements; and I believe that this book first gave me a wish to travel in remote countries, which was ultimately fulfilled by the voyage of the Beagle. In the latter part of my school-life I became passionately fond of shooting; I do not believe that any one could have shown more zeal for the most holy cause than I did for shooting birds. How well I remember killing my first snipe, and my excitement was so great that I had much difficulty in reloading my gun from the trembling of my hands! This taste long continued, and I became a very good shot. When at Cambridge, I used to practice throwing up my gun to my shoulder before a looking-glass, to see that I threw it up straight. Another and better plan was to get a friend to wave about a lighted candle, and then to fire at it with a cap on the nipple, and if the aim was accurate the little puff of air would blow out the candle. The explosion of the cap caused a sharp crack, and I was told that the tutor of the college remarked, "What an extraordinary thing it is, Mr. Darwin seems to spend hours in cracking a horse-whip in his room, for I often hear the crack when I pass under his windows!"

I had many friends among the school-boys whom I loved dearly, and I think that my disposition was then very affectionate.

With respect to science, I continued collecting minerals with much zeal, but quite unscientifically—all that I cared about was a new-*named* mineral, and I hardly attempted to classify them. I must have observed insects with some little care, for when, ten years old (1819), I went for three weeks to Plas Edwards on the sea-coast in Wales, I was very much interested and surprised at seeing a large black and scarlet hemipterous insect, many moths (*Zygæna*), and a cicindela, which are not found in Shropshire. I almost made up my mind to begin collecting all the insects which I could find dead, for, on consulting my sister, I concluded that it was not right to kill insects for the sake of making a collection. From reading White's "Selborne," I took much pleasure in watching the habits of birds, and even made notes on the subject. In my simplicity I remember wondering why every gentleman did not become an ornithologist.

Toward the close of my school-life, my brother worked hard at chemistry, and made a fair laboratory with proper apparatus, in the tool-house in the garden, and I was allowed to aid him as a servant in most of his experiments. He made all the gases and many compounds, and I read with great care several books on chemistry, such as Henry and Parkes's "Chemical Catechism." The subject interested me greatly, and we often used to go on working till rather late at night. This was the best part of my education at school, for it showed me practically the meaning of experimental science. The fact that we worked at chemistry somehow got known at school, and, as it was an unprecedented fact, I was nicknamed "Gas." I was also once publicly rebuked by the head-master, Dr. Butler, for thus wasting my time on such useless subjects; and he called me, very unjustly, a *poco curante*, and, as I did not understand what he meant, it seemed to me a fearful reproach.

THOUGHT AND LANGUAGE.

By DANIEL GREENLEAF THOMPSON.

MODERN philosophers and psychologists have acknowledged in no equivocal terms the great debt which thought owes to language. They have unhesitatingly admitted that without language little progress could have been made in the development of the thinking powers and their product, knowledge. It has been conceded to be the principal expression of thought and feeling, and the chief means of communication between one mind and another. Many writers upon the science of mind have even deemed that, before proceeding to an examination of the mental powers and their exercises, some analysis of language as the supreme instrument of thought was a "necessary preliminary" (Mill's "Logic").

Notwithstanding these emphatic and cordial tributes to the importance of linguistic systems to the growth of intelligence, proceeding both from the Lockian and the Kantian side of philosophical debate, Professor F. Max Müller is not satisfied with the position thus accorded to language in its relations to psychological science. He comes forward to contend* that thought without language (or its

* "The Science of Thought." New York: Charles Scribner's Sons, 1887. 2 vols., pp. 325, 330. Price per vol., $2.

"No reason without language,
No language without reason."

equivalent embodiment) is not possible, that the science of the growth and development of language is the only true science of the growth and development of mind, and that "this revelation of the oneness of thought and language means a complete revolution in philosophy" (vol. i, p. 50).

It is not needful for us to speak of Professor Max Müller's right to be heard on any subject to which he devotes his attention, nor of his erudition, his agreeable literary style, the service he has rendered to science and literature, nor of the lovable personal character of the man. All these things everybody allows. Our purpose then, is—premising that "The Science of Thought" is full of interest, and displays, as usual in his books, the author's great philological learning—to examine the main thesis of the work; to determine, if possible, whether it is true, and, if so, whether or not it effects any "revolution in philosophy."

"The Science of Thought" is not a general psychological treatise. It is an adjunct to the science of language, to which it belongs, rather than to psychology. It is less expository than polemical, and the gist of the work is the argument to prove that thought (in the author's meaning of the term) depends absolutely upon language, and that the way to study the human mind is to study human language.

Of course, it is essential to note carefully in the first place the author's use of the term "thought." His book has aroused quite a controversy already, and a dozen or more letters on the subject have been published in "Nature," and reproduced in "The Open Court," of Chicago. They are from the pens of Francis Galton, the Duke of Argyll, Mr. Hyde Clark, Mr. T. Mellard Reade, George J. Romanes, and others, with replies by Professor Max Müller. They present various considerations to show the error of the latter, such as the cases of deaf-and-dumb people, sudden aphasia in disease, and the results of personal introspection. Mr. Galton in one of his letters charges that Professor Müller has not told the reader what he means by "thought," to which the author rather indignantly replies that the definition is found on his first page, which at least it is usual for reviewers of books to look at, if they go no farther. After so explicit a direction, we certainly shall not incur the reproach of saying that there is no such definition; but, in our judgment, the author would have succeeded better if he had left his definition more indefinite.

Professor Max Müller means by thought "the act of thinking," and by thinking "no more than combining." "I think, means the same as the Latin *cogito*, namely, *co-agito*, 'I bring together,' only with the proviso that bringing together or combining implies separating, for we can not combine two or many things without at the same time separating them from all the rest. Hobbes expressed the same truth long ago, when he said that all our thinking consisted in addition and subtraction." "Much, however, depends upon what we combine and separate," and hence we must consider the material of our thoughts, "the elements which we bring together or co-agitate." These are sensations, percepts, concepts, and names. These, though distinguishable, never exist in reality as separate entities. "No words are possible without concepts, no concepts without percepts, no percepts without sensations." The author then attempts to show, in reverse order, that "sensations are impossible without percepts, and percepts without concepts, just as the cloth is impossible without the threads, and the threads without the wool." This made out to his satisfaction, the argument follows that concepts are impossible without words—hence percepts and sensations are impossible; and thus thinking is not possible without language.

It would be much easier to deal with Professor Müller's reasoning if it were not complicated by various qualifications of the above simple statements, which make his meaning somewhat doubtful. He declares in one place that "thoughts may exist without words, because other signs may take the place of words. Five fingers or five lines are quite sufficient to convey the concept of five between people speaking different languages, possibly between deaf-and-dumb people who speak no language at all." Thus, it seems, we are to consider language as consisting of other signs as well as words. This, however, is not to affect the general proposition. Again, the author does in his book concede that we can reason without words, but in his letter to Galton of May 15, 1887, he declares that this "is no more than reasoning without pronouncing words." It is "symbolic, abbreviated, or hushed language," which "presupposes the former existence of words." Moreover, in this same letter, he avers that "sensation, passions, and intuitive judgments . . . clearly require no words for their realization." He also implies that seeing, feeling, acting—all may take place without what he terms thinking. "Instantaneous and thoughtless action is often more successful than the slow results of reasoning." But without seeking for further illustration, enough has been noted to show that Professor Müller has not clearly and consistently developed his own doctrine.

If thinking is bringing together or combining, addition with its complementary subtraction, the question arises, whether we are to apply the term to the combining into unity which is necessary in every act of knowing, in order to make that presentation of an object to the subject which is cognition itself, or to that combination which we ordinarily designate by the term *association*. My eye rests upon a patch of color on the wall; the cognition of this as an object involves "co-agitation" or combining. Surely we are not asked to believe that the presentation of this to the mind as an integer, and the holding of the mind's attention upon it, is impossible without language! It can not be that this is thinking in Professor Müller's intended sense of the word. Rather, he means association. "The very moment we become conscious of a percept, or of an individual object, we have to comprehend it under something else, and thus to begin to conceive it, even if it be under the most general categories of our mind. . . . Any green, as soon as it is perceived as this green, is *ipso facto* perceived as like unto other greens, and as unlike yellow and blue; it is conceived as something which we afterward call color." These words aim to express the natural process of association which occurs in every mind, indeed, and Professor Müller's chief point is that this can not take place without language.

Let us consider for a moment the author's division of the material or elements of thought into sensations, percepts, concepts, and names. The question is at once suggested, Why are not names, percepts? A name is certainly a word, or set of words, and a word is nothing to our intelligence except as brought or to be brought to our ear or eye by the ordinary processes of sensation, and perceived by our intelligence. We may, it is true, invent a word by our constructive activity, but it is at once objectified, and when communicated to others it is to them a percept. Whatever may be its offices besides, it is at least this. Its additional office is by itself, or in conjunction with other words, to constitute a name; and a name is a mark or a symbol, serving the double purpose to recall to ourselves some previous object of cognition, and to make it known to others. This is accomplished according to the laws of association and representation. Names, then, are certain symbolical percepts, which, by the processes of redintegration recall past experiences. Now, it is idle to say that word-percepts are essential to this course of mental operation; one green will recall another green without any word being needed. The picture of the Matterhorn before my eyes instantly brings back to me the Matterhorn as I saw it from the Riffel; this suggests the Breithorn, Monte Rosa, my view from the summit of the latter, and a whole train of personal recollections, just as infallibly and certainly as the word *Matterhorn*, which I find on the printed page. I do not deny that in the train first suggested words interpolate themselves; but I maintain that the picture of the Matterhorn reproduces in my mind the actual sight without need of the intervention of any name, and before the name occurs. Now, suppose that the picture be one of a mountain I have seen, but of which I do not recall the name. I remember at once the visual appearance; the words "mountain," "peak," "horn," "pic," "ice," etc., do not come to my mind, nor does any one of them nor any word or name. The sight I beheld is there, and then I try to think of the name of the mountain or the locality. So that if Professor Müller means to declare that we can not represent or associate ("combine or co-agitate") except by the use of language, intending by language articulate words, certainly universal experience negatives his assertion. But, if under language be included everything which recalls to the mind something else, his statement reduces itself to the proposition that we can not think (that is, combine, associate) without mental objects to associate, and that every mental object is a portion of language. To assert this would not be a "revolution in philosophy," but we might properly call it a revolution in the science of language.

Let us now consider the formation of concepts or general notions upon which the author lays so much stress as supporting his theory. Professor Müller brings forward the doctrine of Locke, Berkeley, and Hume, that "a general is nothing but a particular idea annexed to a general term—that is, to a term from which a customary conjunction has a relation to many other particular ideas and readily recalls them in imagination." It can not be doubted that there is substantial truth in this statement, though it needs qualification, but it does not prove Professor Müller's point. There must, indeed, be a *fundamentum* in every general notion, a nucleus, a type, a symbol. When we have in our minds the general notion *horse*, we have some particular horse, either remembered or constructed in imagination from former experiences of horses. With this goes the cognition that there are other objects like this one. To elucidate, I may, perhaps, be permitted to quote from a former analysis of my own: * "Whatever association brings up the concept evokes the cognition of one or a small plural number of individuals which are either remembered as wholes or constructed out of remembered parts, and with which is associated the idea that there is a number of objects not definitely recalled which are similar to the individuals before the mind in the particulars characterizing the concept. . . . When we think of *man*, we remember a particular man, or imagine one; or the mind runs over the representations of several men, after which it rests content with the idea of an indefinite number of men about the same as those ideally presented." Now, the office of a name in such a connection is to furnish a connecting link in thought between a present cognition (or experience generally) and past ones. When I see a moving object in the distance, and as it comes nearer I identify it, I doubtless think by saying to myself, "It is a man." But if I see a strange creature, the likeness of which I had never seen but once before, and which, so far as I am concerned, is nameless, when I observe the second, the first is recalled, and identification takes place. This is just as much thought as if there were the intervention of a name. Suppose I see a third creature, which, by representative association, I class with the other two. Common characters are noticed, and I begin the formation of a general notion. This is completely done by the mere association of any striking resemblance, as a horn, a spotted skin, a peculiar howl, an odor. Any one of these peculiarities may form the nucleus or mark which will recall the creature, and knowledge of it can be communicated to others by gesture, by a picture, or by a word. Thought consists in identification and discrimination in present and past experiences, and between

* "A System of Psychology," Chapter L, Longmans, 1884.

the two. Predication is the expression of a judgment, and a judgment is a cognition of agreement or difference; this takes place constantly without language, which latter only facilitates the processes of association. Indeed, a little reflection will convince us that language itself is not logically possible without prior thought. For a word or a name only becomes such by a process of thinking. It must be first fixed by association before it begins to do duty. Before I cognize an object, as a horse, the term *horse* itself must have become associated with other objects which have come into experience. If the attaching of a word *horse*, a percept, to another percept—a horse actually seen, as the mark of the latter, is not thinking; then the association of the horse seen with the word *horse* established as a mark of past experiences can not be thinking, for the two processes are precisely the same. The truth is, that both processes are thought. We may freely admit a great deal that Professor Müller asserts; but when we follow out his own propositions to their proper sequences, we find that his thesis is only true on the hypothesis that *language and objects of cognition* are convertible terms. People ordinarily understand that language consists of articulate words. Communication of one mind with another may take place by gestures, facial expressions, contortions of the body, inarticulate sounds, or by simple touch. But none of these are properly language. Written words are symbolic of spoken words, which are themselves articulations of the voice, and, while the former perform the office of concentrating, recording, and perpetuating mental experiences, as do many other symbols, their essential character, as *language*, consists in their relation to articulate communication.

While our author declares himself to be an evolutionist in general, certainly in the science of language, he brings out as a prominent consequence of the truth of his theory of thought, the untruth of that particular doctrine, commonly known as the Darwinian—namely, that man is descended from lower forms of animal life. This Professor Müller asserts to be impossible; and the proof is that animals have no language or any capacity to form language. "If concepts are impossible without names, . . . we then have a right to say that the whole genus man possesses something—namely, language, of which no trace can be found even in the most highly-developed animal, and that therefore a genealogical descent of man from animal is impossible." It may be admitted freely that animals have sensations and percepts; they feel, they perceive, they remember, they act. But concepts they do not have. They are without the power of forming general notions. This is evidenced in the fact that they are without language, concepts being impossible without names. Now, it is quite obvious, to the casual reader even, that Professor Müller has destroyed his own argument on this point by his previous positions. For he takes considerable pains to prove that percepts are impossible without concepts, and sensations without percepts. He maintains that no perception occurs without a generalizing movement. "All percepts are conceptual." This being so, what becomes of the claim that brutes, with feeling and ability to perceive, do not form concepts? And if, as the author reluctantly does in one place, we concede that perception may exist with only "incipient concepts," what should prevent the development of the generalizing power in successive individuals to the degree that it is found in the highest intelligence?

The considerations adduced by Professor Müller on the question of the origin of species, and the descent of man, present nothing, therefore, for the "Darwinian" to answer, except the fact that man has articulate language, and brutes do not have it. This fact has been allowed its full weight in the great discussions upon the descent of man, of which our limits will not permit us to give even a *résumé*. It is sufficient to remark that whatever strength may lie in the argument from this circumstance, its force is not great enough to countervail the many converging proofs of the Darwinian hypothesis; and, further, we may safely reiterate with Darwin that "the faculty of articulate speech in itself does not offer any insuperable objection to the belief that man has been developed from some lower animal." Indeed, the wonder is that Professor Müller's own philosophy of mind should not have caused him to see that the difference between the mind of the brute and the mind of man is one of degree, not of kind. He lays great stress on the unity of mental action. The mind is one in all its exercises. There is no sensation without perception, and so forth, as already instanced. If, then, he can not doubt that a lower animal has some intelligence, the inference must be that the essential characters of the other mental exercises are in the animal's intelligence, at least in embryo. We may believe that Professor Müller is right in much of what he says as to the unity of cognitive exercises. Attention to an object presented, association and representation, are the primary mental processes, and each is necessary to the other. Given these, all the products of thought that we designate by such terms as concepts, inferences, fictions, memories, are readily explicable and their relations to each other made manifest. The chief difference between the mind of man and that of the brute lies in the complexity of association and representation. Man's inferences reach farther, and his generalizations are higher, more complex, and more abstract. It is the same sort of difference which subsists between the intellectually cultivated man and the savage, though, of course, this difference is greater when we compare man with even the higher brutes. But in the latter the same processes are observable. They attend, they associate, they represent; they feel and they act; they have nervous systems; they have mental communication. I see no escape from the conclusion that they generalize, and I would not be at all surprised if it should some time happen that an ape be taught to use articulate language.

Much more might be remarked in refutation of Professor Müller's thesis, but I have probably already tired the reader's patience. I hope enough has been said to show that this learned author has not even brought out a clear and consistent statement of his own position, much less to have effected any "revolution in philosophy." I have not discussed his theory of the formation of roots in language, for such a discussion seems unnecessary after the examination thus far made into the nature of thought. Nor do I stop to consider his lament over the neglect of Kant among later English thinkers. I can see no evidence that Kant has been neglected or failed to receive the attention that is his due; but all this is quite irrelevant to Professor Müller's argument. As for the latter it is self-contradicted in his own book, and any thorough analysis of mental operations would, as seems to me, independently demonstrate its fallaciousness. Altogether, the impression made upon the reader of "The Science of Thought" is that of a work written by a man, who, possessed by his favorite science, endeavors to use it for the explanation of all other sciences without much reference to the results which an unbiased and dispassionate study of those sciences would yield.

Professor Müller informs us that his book was written for himself and for a few friends, with whom he has been traveling for many years on the same road. We are grateful for the permission to join this band of peripatetics for the while, and, if pressing duties elsewhere oblige us to part from them, we can cordially thank Professor Müller for a charming entertainment, reserving, of course, to ourselves that liberty, which all good society allows, of afterward abusing the company.

THE METALS OF ANCIENT CHALDEA.

By M. P. E. BERTHELOT.

IN the pursuit of my studies of the origins of alchemy and the metals of antiquity, I have had occasion to examine substances recovered from the Palace of Sargon at Khorsabad, and from the excavations made by M. de Sarzec at Tello, as they are preserved in the Museum of the Louvre. I intend to describe the results of my analyses, and then to examine a number of new or little-known documents relative to the origin of the tin used by the ancients in the manufacture of bronze.

In the course of his excavations, in 1854, M. Place discovered, under one of the angular stones of the Palace of Sargon, at Khorsabad, a stone chest containing votive tablets, covered with very clear cuneiform inscriptions commemorating the foundation of the building, B. C. 706. According to M. Place, there were five of these tablets; but the form of the inscriptions indicates that there were seven of them, designated by names. Only four of them are in the Louvre Museum, the other three are lost. The four which are known bear long and detailed inscriptions, of which M. Oppert has published translations of three in M. Place's work on "Nineveh and Assyria." The sense is nearly the same in all the three, and relates to the construction of the palace. According to this translation, the tablets were of gold, silver, copper, and two other substances, the names of which have been identified with lead and tin—the last rather doubtfully, according to M. Oppert; and, lastly, of two additional substances, bearing the determinatives of stones employed as materials of construction, which are considered to be marble and alabaster. Unfortunately, the several tablets do not contain separately the name of the material of which they are made. I have examined the four tablets in the Louvre. They are rectangular, and a few millimetres in thickness. The golden plate is the thinnest, and may be easily recognized, although it has lost its brightness. It weighs about 167 grammes. It was shaped by hammering. The metal is not alloyed in any notable proportion. The silver plate is quite or nearly as pure. It is slightly blackened on the surface by the formation of a sulphuret, as usually happens to silver which has been exposed for a long time to atmospheric agencies. It weighs about 435 grammes.

I give these weights as matters of fact, without prepossession on the question of whether they corresponded with the relative values of the metals at the time of the foundation of the palace.

The plate supposed to be of copper is deeply altered and partly exfoliated by oxidation. It weighs, in its present condition, 952 grammes, which shows that its dimensions were considerably greater than those of the other two plates. Its color is a dark red, which is determined for the most part by the presence of the protoxide of copper. It is not pure copper, but bronze; a specimen, filed off from the edge, contained, by analysis, tin, 10·04; copper, 85·25; oxygen, etc., 4·71.

Neither lead nor zinc, nor any other metal, is found in noticeable quantity. The proportion of tin corresponds with that in golden-yellow bronze, but the presence of protoxide of copper has changed the color. This composition is also found in a large number of ancient bronzes; of which I will mention only an Egyptian mirror of the seventeenth or eighteenth century B. C., which I once analyzed for M. Marriette. It contained 9 parts of tin and 91 of copper.

The fourth tablet is the most interesting of all, on account of its composition. It weighs about 185 grammes. It is composed of a bright white substance, hard and opaque, carefully cut and polished. It had till now been thought to be of a metallic oxide, and had first been designated as the antimony tablet; others said tin, because it was thought to have been made of a metal which time had gradually oxidized. But neither antimony nor tin possesses the property of undergoing a change of this kind, especially when inclosed in a stone chest.

At most, lead and zinc are susceptible of being converted into oxide or carbonate in a moist medium; but under such conditions they are disintegrated and fall into dust, while the tablet is quite compact and covered with a very fine and extremely clear inscription. Its real nature was therefore a riddle. We then first carefully sounded it, and ascertained that there was no central metallic leaf in its thickness. Chemical analysis indicated that it was a pure, crystallized carbonate of magnesia—a substance that is more refractory to dilute acids and atmospheric agencies than carbonate of lime. The polishing of the tablet appeared to have been completed with the aid of an almost insensible trace of fatty matter, which manifested itself on calcination. We observe here that our magnesia and its salts were not known in antiquity and the middle ages, and that pure and crystallized carbonate of magnesia is a very rare mineral, and was not known by Haüy at the beginning of the present century. But in intimate association with carbonate of lime it constitutes *dolomite*, a very abundant rock. Carbonate of magnesia is found principally in veins intercalated in talcose schists, serpentine, and other magnesian silicates, where it results from the slow decomposition of the rocks by natural agencies. The material of the tablet in question also includes a few traces of silica, which indicate the same origin. The choice of so exceptional a mineral for the fabrication of a sacred tablet can not have been made by chance. It doubtless responded to some particular religious idea. At any rate, it proves that the Assyrians were acquainted with the carbonate of magnesia as a proper substance. To what word did this tablet correspond in the inscription, in which it appears to figure under the name of one of the supposed metals? Notwithstanding the absence of a special denomination on this tablet, M. Oppert believes that it was designated by the word *a-bar*, which had been supposed to mean tin. I thought it might be useful, in the effort to obtain new light in this matter, to analyze the substance of which the great bulls in the Louvre Museum are made, and see if it contained dolomite. The analysis determined, however, that this matter was a crystallized carbonate of lime representing the physical constitution of marble, or rather of that variety of limestone which was formerly confounded, under the name of alabaster, with anhydrous sulphate of lime.

While I was studying the tablets of Khorsabad, M. Heuzey called my attention to some metallic fragments of a vase and a votive figurine which came from M. de Sarzec's excavations at Tello. The fragment represents a portion of a cylindrical circular band which formed the mouth of a cast vase, and had been prepared by melting and casting. A part of the throat that separated this band from the body of the vase proper can still be seen. It is very simple in form, and without any inscription or even light delineation. The surface is covered with a very thin, yellowish-black patina. The mass is formed of a brilliant black metal, the fracture of which exhibits voluminous, glittering crystals, of very hard but fragile material. On analysis it appeared to be nearly pure metallic antimony, containing no notable proportion either of copper, lead, bismuth, or zinc, but only some traces of iron. The patina was an oxysulphuret, which had been formed by the action of the traces of sulphureted hydrogen which exist in the atmosphere. The existence of such a fragment—of a cast vase of pure antimony—is singular, for this metal is not employed pure for any such use in modern industry, although it is often used in alloys; and I know of no similar example in the vessels either of the present or of past times. I had been told, however, that the Japanese used antimony in their manufactures, and I had been presented with a little winged dolphin which was supposed to be made of antimony. But the analysis of this dolphin showed that it was composed of zinc and other associated metals, and was far from being formed of pure antimony. If pure antimony has really been employed by the Japanese—which I doubt—there would have been a curious relation with ancient Chaldean customs.

An extremely curious circumstance, moreover, is the finding of this authentic manufactured fragment of antimony at Tello, a place which had been uninhabited since the time of the Parthians, and which contains the remains of the oldest Chaldean civilization. Antimony, in fact, is supposed not to have been known to the ancients, and not to have been discovered till toward the fifteenth century. Yet we find that the ancients were very well acquainted with our sulphuret of antimony, a natural mineral which they called *stibium* or *stimme*, and which they employed for many uses, particularly in medicine. A passage in Dioscorides, repeated by Pliny, leads me to believe that metallic antimony had been obtained in his time. We read, in short, in Dioscorides ("Materia Medica," book iv, chapter xcix): "This mineral is burned by placing it on coals and blowing them to incandescence; if the calcining is prolonged, it changes into lead (μολυθδοῦται)." Pliny says, likewise ("Hist. Nat.," book xxxiii, chapter xxxiv): "The calcining must be done with precaution, in order not to change it into lead (*ne plumbum fiat*)." These observations agree with phenomena well known to chemists. In fact, the calcining of sulphuret of antimony, particularly in the presence of charcoal, may easily bring it to the condition of fusible and metallic antimony, a substance which Pliny and his contemporaries confounded along with all other dark and easily fusible metals, with lead. The existence of the Tello vase proves that in Mesopotamia, likewise, and in probably a much more ancient age, they had tried to make cast vases with this supposed variety of lead, which was less liable to change than ordinary lead.

The metallic votive figurine of Tello suggests no less curious observations. It represents a divine personage, kneeling and holding a kind of metallic point or cone. It has engraved upon it the name of

Gudeah, a king who belongs to the most ancient age of which relics have yet been found in Mesopotamia—M. Oppert attributing to him an antiquity of four thousand years B. C. We are thus carried back to extremely remote times of metallurgical history. The figurine is covered with a thick, green patina, below which is a red layer, formed by the oxidation of the metal in the greater part of its thickness. Then comes a red metallic nucleus, having the appearance and tenacity of copper. It is the last remainder of the primitive metal, which has been progressively destroyed by natural actions. I have analyzed these different parts. The superficial green patina is a mixture of oxide of copper and a hydrated oxychloride of copper, the latter compound being known by mineralogists as *atakamite*. It is formed by the action on the metal of brackish waters, with which the figurine had been in contact, through the course of ages. The middle layer is a nearly pure protoxide of copper, free from notable quantities of tin, antimony, lead, or any similar metal. It results from a slow alteration of metallic copper. The nucleus was pure metallic copper.

The absence of any other metal than copper in this figurine deserves to be noticed. Objects of this kind are usually made with bronze, an alloy of tin and copper which is harder and more easily worked. The absence of tin from the Tello copper has a peculiar historical significance. Tin is much less diffused over the surface of the earth than copper, and its transportation has always been the object of a special commerce, in ancient days as well as in ours. In Asia, in particular, there had not till very lately been any deposits of tin found in any abundance except those of the Sunda Islands and the southern provinces of China. The transportation of this tin to Western Asia was formerly carried on by sea, to the Persian Gulf and the Red Sea, by long and arduous voyages; and it was carried thence to the coasts of the Mediterranean, where it came in competition with the tin of the British Isles which had been brought across Gaul, and with the less abundant deposits of Central Gaul, and, perhaps, also of Saxony and Bohemia. Voyages so long and arduous, and systems of navigation so difficult could not have been established till after many centuries of civilization. The Phœnicians, who had come from the borders of the Persian Gulf to those of the Mediterranean, seem to have been the first promoters of this navigation.

But I have recently become cognizant with two documents, which tend to fix a less distant origin for the tin of the bronzes of Assyria and Egypt. According to a note published by M. G. Bapst, a Russian traveler, M. Ogorodnikoff, was informed by the inhabitants of Meshed that there were at one hundred and twenty kilometres from that city, and at various places in Khorassan, mines of tin now worked. These statements should, however, be received with caution, on account of the uncertain quality of the oral declarations of Tartars. But it is a remarkable fact that they agree to some extent with a passage in Strabo that has been pointed out to me by M. P. Tannery. Strabo (book xv, chapter xi, 10) mentions tin-mines in Drangiana, a region which corresponds with our Khorassan, below Herat, and toward the western boundaries of modern Afghanistan.

While tin is rare throughout the world, it is very different with copper, the ores of which are found at a great number of points. The mines of Sinai, not to mention more distant ones, were celebrated in ancient Egypt. The extraction of metallic copper from its ores is also easy. Reasoning from these facts, many archæologists have supposed that an age of pure copper, or an age in which arms and tools were made of this metal, preceded the bronze age. In order to judge the value of this hypothesis and determine the date at which this ancient navigation began, it would be necessary to possess the analyses of the most ancient objects to which a certain date can be fixed, among the remains of antiquity that have come down to us. According to analyses of this character, bronze existed in Egypt nearly two thousand years before the Christian era. The analysis of the figurine of Tello seems to indicate, on the other hand, that tin was not yet known at the time when that object was made, or that it had not yet been brought to the Persian Gulf. This is, however, only an induction, since some religious circumstance or another may have determined the exclusive employment of copper in the making of the figurine; and it would be necessary to examine many more objects and more various to reach certainty in that matter. It has, nevertheless, seemed to me that it would be interesting to indicate the problems of a general character that are raised by the analyses of the metals of Tello.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

OUR FORESTRY-PROBLEM.*

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DOUBTLESS you have all seen, during the last ten years, numerous references in newspapers, magazines, etc., to the necessity of forest-preservation. This plea, however, even in this country, is not as novel and of as recent date as may be imagined. As far back as our colonial times, the fear of an exhaustion of lumber-supply alarmed New England legislators; and as early as 1801, the Massachusetts Society offered its prizes for timber-planting. We may smile over the fears of those times when railroads had not yet revolutionized methods of transportation, bringing the whole world under contribution for supplies. Yet, while those fears were premature, they were nevertheless prophetic, and the very railroads which have opened up the vast forest

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areas of the Northwest have brought rapidly near to us the possibility of a time when a scarcity of wood may be felt. For the haulage over so long distances of so bulky freight, in addition to other obstacles, allows only a small amount of the timber growing in those distant forests to be profitably moved to market, and from fifty to sixty per cent, often even more, of the trees cut is left in the woods to rot or to furnish food for the yearly conflagrations. Even now, in the more remote lumber-camps, any part of a tree less than one foot in diameter is considered unprofitable, and is left in the woods.

But while—as I will show farther on—the fear of those early alarmists is with renewed force, and upon a more reasonable basis, again pressed upon us, other considerations besides a waning lumber-supply compel our attention to forest-preservation. A vague idea that some connection existed between the forest-cover and the climatic conditions of a country has been prevalent from olden times. "The tree is the mother of the fountain," or "the father of the rain," are significant expressions of the sages of old. But it was due to the representations of such eminent naturalists as Humboldt, Boussingault, and Becquerel, that the important and complicated part which the forest plays in the economy of Nature was first clearly recognized. And now, in the light of recent scientific experiments and investigations, added to the historical evidence of earlier times, we are forced to consider the forests of a country in a fourfold aspect:

1. As furnishers of raw material.
2. As regulators of climatic conditions.
3. As regulators of hydrologic conditions, influencing the water-flow in springs, brooks, and rivers.
4. As regulators of soil-conditions.

I need not stop to call to your mind the endless variety of articles into which the product of the forest enters. There is hardly any manufacture, hardly any branch of human industry, in which wood does not find application in some way or other; and we can say, without exaggeration, that the progress of the human race in civilization has been largely dependent on this material. A continued supply of such an important substance must, then, be deemed a necessity. To the assertion that substitutes are being and will be easily found, I would reply that, with the invention of substitutes, new applications of wood are also invented; that with the growth of civilization the use of wood has grown disproportionately; and that the population of the earth is constantly increasing, so that substitutes would have to be found to meet a demand for wood by far greater than that of the present. Besides, if we can, by reasonably husbanding present supplies, and by exercise of management, prolong for the human race the use of this most convenient material, should we not rather curb our spendthrift tendencies than rely upon the ingenuity of our children in supplying substitutes?

The value of the forest as a producer gains additional significance in the economy of a nation from the fact that it yields a return on land which for other purposes may be useless. Timber is the crop which we can raise on our wastes and barrens, and which enriches and improves the soil instead of exhausting it. For the forest-tree generates most of its substance from the carbonic acid of the atmosphere through assimilation in the leaves, while from the soil it requires mainly water, most of which and of the exceedingly small amounts of mineral food that enter its composition, are derived from the deeper strata. The greater part of this mineral food is returned by the falling leaves to the surface of the soil, and thus that circulation of matter is set up which makes forest-growing a means of improving poor soils.

The prospects of private gain might seem to be sufficient to insure the raising of timber as well as of grain or vegetables to the full extent desirable. But against the advantages of the wood-crop just mentioned must be set certain drawbacks. The agricultural crop is produced in one year, during which it is easy, by constant cultivation, to keep up favorable conditions, and the expenditures yield their profit within a year's time. The forest-crop requires ten, twenty, forty, nay one hundred and more years to grow to useful size, does not admit of much aid on the part of the cultivator, and must have the favorable conditions for its development provided in the methods by which it is originated. It not only requires a greater amount of capital, but a greater amount of foresight, to carry on a systematic forestry with similar objects in view to those of systematic agriculture.

. . . .

Here, however, enters the *national* interest in the business of forestry, based upon the indirect significance of the forest, namely, its influence on climate, water-flow, and soil. Even in ancient times this significance was vaguely realized, when Critias spoke of the "sickness of the country in consequence of deforestation." The earliest written expression which ascribes to the forest a definite influence upon climatic conditions we owe to the Spaniard, Fernando Colon (about the year 1540), when he states that, "on Madeira, and the Azores and Canary Islands, the rains have become rarer since the trees, which spread their shade, were cut down." In later times we find similar observations and allusions to this connection between forests and climatic or agricultural conditions in the literature of almost all civilized nations.

But these occasional notes assumed a practical significance only when, after the extensive clearings which were perpetrated by an unbridled populace during the French Revolution, the injurious consequences upon some of the most fertile districts of France made themselves felt, when fields and pastures which had sustained a thrifty and prosperous population were turned into sand-wastes or made sterile by torrential action of mountain-streams, carrying away the fertile soil, and substituting *débris* and unfertile ground from the mountains, and pauperizing the once productive lands, inflicting damages, which now, by the expenditure of millions of dollars yearly, and with the exercise of the greatest ingenuity, can hardly be repaired. Within the last twenty years, France has reforested about two hundred and fifty thousand acres of mountain-lands, at a cost of $30,000,000 of which the Government paid one half, the local communities the other half. In addition, two hundred thousand acres of sand-dunes, which were the result of injudicious clearing, have been reforested since 1862, and thus been made productive.

An extensive literature on the subject of forest benefits has now accumulated. But I do not intend to rehearse these often-cited arguments, which are so well elaborated in George P. Marsh's classical book, "The Earth as modified by Man." We must admit, however, that historical evidence alone can not be held sufficient proof of any natural law, and a problem of natural science needs for its solution to be subjected to scientific methods of investigation and reasoning. This has only lately been done with regard to forest influences; and, though systematic and continuous observations have not yet extended over a long period, we are already prepared at least to understand the character, though not always the extent, of the part which the forest plays in the economy of Nature. We have learned to discriminate between the different functions of forest influences. We have learned that the mechanical influence of forest-cover upon hydrologic and soil conditions is undeniable; we have learned that climatic changes due to deforestation may be favorable as well as unfavorable; that the great characteristics of a climate, due to cosmic conditions, such as the twofold movement of the earth, the presence of water-surfaces, elevation, the prevailing winds, etc., are probably beyond the reach of forest influence; that such influence must, in the main, be local, and its nature and extent be dependent largely upon the geography of the locality.

The *rationale* of forest influences is easily enough understood, if we consider them step by step. The climate of a locality—i. e., the interdependent oscillations of temperature and humidity of the air (not as it is popularly expressed the *mean* condition of these factors)—is, in the first place, dependent upon the heating effect of the sun's rays; in one word, upon "insolation." The temperature of the air derives its heat, for the most part, only from contact with the heated earth or objects on the earth, and by radiation from these. Any mechanical barrier, then, against insolation of the soil, like a shady, dense forest, must have the effect of lowering the temperature of the soil and consequently of the air above it. The immediate consequence of this is diminished evaporation from the surface of the soil; while, on the other hand, the transpiration through the leaves makes the ground-water of greater depths available to the atmosphere. Thus cooler and moister air is found within and above the forest, which is communicated to the surroundings, and tends to bring to condensation any passing clouds, which the hot air ascending from the open field would have prevented. In this manner the forest acts exactly like a large sheet of water, as a starting-point of local winds, by which the characteristic features of the forest climate—i. e., shorter range of thermometrical extremes, and greater humidity—are communicated to the surroundings. Yet, whether under all circumstances, a direct increase of precipitation over surrounding areas may be produced through forest influence remains still unproved, and appreciable effects can only be expected from dense and extensive forest areas.

The influence of a mechanical barrier against chilling northern and hot southern blasts, such as even a simple wind-break of two or three rows of trees can produce, is well known to the prairie settler. But by far the most important function of the forest lies in the preservation of soil-humidity and in the storage and equable distribution of the water capital of the earth. The moss and leaf-mold act as a sponge, taking up all the atmospheric water which reaches them, and only gradually give up the same to the soil, from which it reappears as springs, brooks, and rivulets, forming the great water reservoir of agricultural lands, giving up its accumulations gradually throughout the season when most needed. While this beneficial action is especially noticeable in the mountainous regions, the forest of the plains acts also as a regulator of hydrologic conditions, as is apparent from the observation that on deforested areas the ground-water level sinks and aridity increases. While the large floods are probably, to a great extent, due to cosmic causes, yet it can not be denied that the deforestations at head-waters of streams must have aggravated the evil, and that local floods and their concomitants, namely, washing away of soil, pauperizing fertile valleys, etc., can be obviated by proper forestry, has been practically demonstrated by the reforestation in France and the Tyrol. On the paramount importance of the proper utilization of the water capital of the world, a volume might be written. Suffice it to say, that our agricultural development, and with it our civilization, depends upon it.

Lastly, I should recite the sanitary effects of the forest, the investigation of which has, of late, brought many important and interesting results. That the activity of individual trees in assimilating carbonic acid and exhaling oxygen improves the air we breathe has been long a recognized fact, and the healthfulness of forest air is therefore generally conceded. It is asserted that, by deforestation, malarial districts have been created, while, on the other hand, the planting of eucalyptus and other trees is said to have produced the opposite effect. It is quite possible that the manifold ramifications of the crowns of the forest act as a kind of filter in purifying the air of the spores of fungi and bacteria, thus diminishing the danger of epidemics, etc.

To dwell on the æsthetic aspect of the forestry question would lead me too far, though its effect upon national life should not be under-estimated, and deserves fully our attention.

From this hurried review of the relation which the forest-cover of the earth holds toward the economies of Nature, it should appear that more than a private interest must attach to it; that, wherever men are aggregated as a nation or a government for the protection of the public against the willfulness of the few, the care of the forest should receive earnest and timely consideration, and, if necessary, legislative action.

The forestry-problem, then, exists because of the dependence of favorable agricultural conditions upon the existence, proper management, and location of forests, and because the common interest of the nation in the maintenance of such conditions does not find a responsive appreciation on the part of those private citizens who own the forests, and who refuse to be restricted in the exercise of their free-will and their property rights in respect to them, though they suffer a number of other interferences imposed for the common good without grumbling. The forestry-problem is, to reconcile and adjust these opposing interests, and, either by persuasion or coercion, to insure the preservation and the conservative management of forest areas whose devastation would injure the interests of the whole community, and also to encourage the creation of new forest areas where needed.

Let us now ask, How far are we concerned in this forestry-problem in this country at the present time? Is the condition of our forests, in comparison with our present and future demands upon them, such as to make the immediate consideration and speedy solution of the problem a necessity? Has the time arrived for us when the needs of the future should be considered in our actions in the present?

First, in regard to material supplies: it is a most difficult task to arrive at precise data from which to judge as to supplies at hand; and still more difficult, if not impossible, to predict exhaustion or the time of scarcity. The way of speaking on this aspect of the question has, by necessity, been without proper basis. The vast stretches of so-called forest still standing encouraged the notion that exhaustion was impossible—that Nature's provisions would, unaided, recuperate the drains made upon her. "Anyhow, there are a good many years' supplies ahead." Supplies of what, and for what demands? It is evident that we should discern, for instance, between building-timber supplies and hard-wood supplies, which latter, for useful purposes, are reproduced by Nature more easily and in shorter time. Unfortunately, we lack sufficient data to make any such discrimination; but we know tolerably well that the "inexhaustible" white-pine forests of the Northwest, which have supplied the bulk of our building material, will practically be exhausted in a very few years. The hemlock is soon to follow. We hear it stated that the capacity of the Northern mills, which have depleted, in less than fifty years, a crop which it takes one hundred and fifty years to replace, is sufficient to rob the immense forest areas of the South of their valuable timber in very much less than twenty-five years—timber which it has taken one hundred and fifty to two hundred and fifty years to grow; and, though almost inconceivable quantities of standing timber are reported from the Pacific coast, even with the utmost stretch of the imagination, considering the wasteful manner in which that supply is being consumed, there can not be a sufficient supply standing to meet the present requirements of the whole nation for fifty years.

It is a most farcical attempt at deception which has been practiced in comparing the supplies of one particular region with the present requirements of that region. We are one country, one nation; and, unless we build Chinese walls around our different sections, the resources of the entire country must be placed in comparison with the requirements of the entire country. The only rational way of looking at the requirements and supplies of a large continental nation like ours seems to me the following: According to latest estimates, we consume yearly, with our present population of sixty million, not less than twenty billion cubic feet of wood. This amount is made up, in round figures, in the following manner:

2,500,000,000 feet for lumber-market and wood-manufactures;
360,000,000 feet for railroad construction;
250,000,000 feet for charcoal;
500,000,000 feet for fence material, etc.;
17,500,000,000 feet for fuel.

To this it will be safe to add, for wasteful practices and for the destruction by yearly conflagrations, at the least, twenty-five per cent.

The average yearly growth of wood per acre in the well-stocked and well-cared-for forests of Germany has been computed at fifty cubic feet. Applying this figure to our present requirements, we should have an area of not less than five hundred million acres in well-stocked forest to give us a continual supply of all kinds for our present needs. Now, a careful canvass made four years ago developed the result that the existing forest area in the United States, excluding Alaska and Indian Territory, comprised almost five hundred million acres (489,280,000); but it is well known to everybody who is acquainted with our forests that they can not compare in yield with the average European continental forests under systematic management. Much of what is reported as forest is useless brush-land, or open woods, and depreciated in its capacity for wood-production by annual fires, by which the physical structure of the leaf-mold is destroyed, and thus, too, its capacity for storing the needful moisture, reducing wood-production, and killing all young growth.

Without care, without management, and left to the kind but uneconomical work of Nature, interfered with, in addition, by rude and ignorant action of man, it is doubtful whether, on the existing area, one half the amount of wood is produced yearly which we now require. We have, therefore, beyond doubt, reached—if not passed—the time when increased drain means squandering of capital, and when regard to husbanding, to careful management, to recuperation of our forests, and planting of new forests is required for the purpose of merely furnishing raw material; and it should not be forgotten that to reproduce the quick-growing white pine of an acceptable quality and sufficient size, requires not less than eighty to one hundred years, and for the long-leaved pine two hundred years; that, altogether, wood-crops are slow crops; that nothing of size can be grown under a quarter of a century at the best.

That this is a business requiring intelligent national consideration is apparent; not less so if we appreciate the magnitude of the values resulting from it. The total value of forest products in the census year was placed at $700,000,000, or ten times the value of the gold and silver production, five times the value of all coal and mineral production, and exceeding every one of the agricultural crops, corn and wheat not excepted; and representing in value about thirty per cent of the total agricultural production.

Turning to our concern in the climatic aspects of the forestry question, I have recorded my skepticism as regards a wide-reaching forest influence upon the climate of a country; and since the influence can only be local, since its nature and scope depend on geographical position, configuration, elevation, the neighborhood of large water surfaces, and prevailing winds, etc., it is evident that it is entirely impossible to speak of a safe percentage of forest-cover for a continental country like ours. The climatic factors at work and the requirement of regulating influences on the Atlantic shore have no bearing on considerations of the Pacific, and what the treeless plains need may not be needed by the lake-bordered States. A proportion of forest which has been suggested as safe, without any proper basis, however, is twenty-five per cent.

In order to study the need of considering forest climatic influences, I have divided the country roughly, as far as our scanty forest statistics permit, into eight or ten regions, or rather grouped the States together, which are more or less similarly situated as regards possible climatic influences of a cosmic nature. These groups are, to some extent, arbitrary, and, being based upon political divisions, for which alone approximate forest statistics exist, can not closely correspond to the range of actual climatic conditions. It would appear, however, that the Atlantic States, with over forty-three per cent of forest, as well as the Gulf and central Southern States, and even the lake-bordered Northern lumbering States, with nearly fifty per cent of forest-cover, can not, in general, be said to have gone below that safe proportion for climatic considerations; though in special localities the inroads may have been severe enough to produce undesirable results. But the agricultural States—Ohio, Indiana, and Illinois, with 14·7 per cent; the Prairie States, with a continental climate, and with only 4·4 per cent; Texas, with 23·2 per cent, all in one corner; the Rocky Mountain States, with 14·1 per cent of forest-land, and their water-supply depending on the forest-cover; the Pacific slope States, though heavily timbered on the Northwestern coast, with 34 per cent, and in the southern and interior parts largely dependent on irrigation—*these*, I may say, come nearer to that lowest limit of forest-cover which is claimed as desirable for climatic considerations. Especially where the forest had been destroyed, and the climate made unfavorable before the advent of the white man, in the vast prairies, reforestation is demanded for purely climatic amelioration.

This has been recognized by the prairie settlers, tree-planting in shelter-belts and small groves has been begun, and the change for the better, aided by the breaking of the soil in large areas, is gratefully acknowledged. But a radical change in the inclement climate of those plains we can expect only from extensive and densely shaded forest-belts, dispersed over the country, such as only entire communities, or citizens aggregated in a government, will be able to provide.

Of injuries wrought locally by the reckless clearing of hill-sides and of deterioration of the soil due to inconsiderate action of man, I could entertain you by the hour; the country is full of examples. Any one who wishes to study the effect of such denuding of hill-sides upon the soil, the water-flow, and agricultural conditions, need not go to France, Spain, Italy, Greece, or Palestine. The Adirondack Mountains are within easier reach, where the thin cover of earth exposed to the washing rains is carried into the rivers, leaving behind a bare, forbidding rock and desolation, while at Albany the Hudson River is being made unnavigable by the *débris* and soil carried down the river; the Government has spent more than ten million dollars, I believe, and spends every year a goodly sum, to open out a passage over the sand-bar thus formed.

Go to the eastern Rocky Mountains, or to Southern California, and you can gain an insight into the significance of regulated water-supply for the agriculture below, and also learn how imprudently we have acted and are acting upon the knowledge of this significance by allowing the destruction of mountain-forests in the most reckless and unprofitable manner. Along the shores of Lake Michigan, and along the sea-coast, we are creating shifting sands by the removal of the forest-cover, to make work for the ingenuity of our children in devising methods for fixing these sands again. The vegetable mold with which the kind forest had covered the alluvial sands of the Southern coast-plain we are taking pains to burn off in order to replace it with expensive artificial fertilizers.

That the great flood of the Ohio, which cost the country more than twenty million dollars, was entirely due to deforestation, I will not assert, but it must have been considerably aggravated by the accumulation of minor local floods due to the well-known reckless clearing of the hill-sides, which sent their waters down into the river in torrents. At the season, when the winter snows are melting, watch the newspapers, and you will find an almost daily mention of the disastrous ravages of brooks and streams, many of which injuries could have been prevented by avoiding the creation of their distant and indirect cause. Thus we may multiply examples all over the country, showing harmful local influences upon agricultural conditions due to forest devastation.

That the vast stretches of land in the Northwest, from which the white pine has been cut and burned off, present the aspect of a desolation which sickens the heart, you may hear from every one who has seen these deserts unnecessarily wrought by man. Every traveler in this country, be it to the White Mountains, to the Adirondacks, along the Alleghany Mountains; be it through the Rockies or the redwoods of California, can not but be startled by the desolate, sad aspect of many of these once beautifully-clad mountain-crests.

And we are a nation hardly a hundred years old, with over thirty acres per capita to spread ourselves upon. What will become of us, when we must live upon five acres per head? We are far enough advanced in our recklessness of disregarding the indirect significance of forest areas to have learned a lesson at home, and to feel the necessity of being more careful in the utilization of the forest, so as not to lose its protection for our agricultural and general interests.

While we have seen that all aspects, in which the forest must be considered, from the standpoint of national economy, show our conditions to be such as to call for solicitous consideration and action; this is still more apparent, if we analyze the difficulties to be overcome. These are much greater, in our case, than those encountered by any of the European nations. For abroad, government is so regarded as to give wider scope to its action, and not only are government forests and government forestry permissible and natural, but government interference, if for the interest of the general welfare, is borne less impatiently. Besides, forest management by these nations has been gradually led up to by an interest outside of forestry proper—the protection of the chase, which was fostered by the king, and then by nobles, on entailed estates, so that to the present generation a nucleus of forests has been preserved, upon which to expend the needful care and management.

Our difficulties lie mainly in the unique manner in which our country has been settled, and in the spirit of our institutions, which is too prone to resent interference with private rights, even where the common interest seems to call for such. The rapid development of railroad facilities has brought a whole vast continent within easy reach of market, and has allowed a population of only sixty million people to spread itself over more than three million square miles of territory. In consequence, the necessity, or even desirability, for economical use of our resources can hardly be realized. The necessity of clearing woodlands for agricultural purposes, without a market for the timber, has bred a spirit of wastefulness in regard to that material; and this has been fed by the seeming inexhaustibility of existing natural supplies. The vast expanse of our country, with its endless possibilities and opportunities, has produced a tendency of instability and speculation—a tendency inimical to a business whose profits lie so remote as in forestry, and which presupposes a concern in the future conditions and welfare of a given locality.

Add to this the difficulty, over our vast and sparsely-settled country, of guarding forest property against theft and fire, which invites the owner to cut and realize as fast as possible upon his holdings, and deters him from risking any expense on management; further, add that, as long as natural supplies can be brought to market from distant regions, and at prices far below the cost of their production—and all financial incentive to apply systematic forestry is wanting. While thus the ruthless slashing of the primeval forests goes on without regard to future or consequences, the comparatively insignificant beginnings of new plantations in the treeless plains can hardly be considered an attempt at compensation. Time, of course, would cure many of these unfavorable conditions; but meanwhile we are increasing the dangers of deforestation, and are preparing for those who come after us hardships which we could and should avert. How, in spite of the difficulties that oppose a systematic forestry, to insure a continuous and sufficient supply of raw material, and to preserve the favorable conditions which depend on proper forest areas—that is the forestry-problem.

The means for its solution I may only briefly indicate: they are education, example, encouragement, legislation. Some of these are of slow effect; others can be made to give results at once. Let the United States Government, which still holds some seventy million acres of the people's land in forests, mostly on the Western mountains, where its preservation is most urgently needed—let the Government set aside these otherwise valueless lands, and manage them as a national forest domain, and then the first effective step, a feasible and not a forcible one, is made. Let the military reservations on the Western treeless plains, which are still in the hands of the General Government, be planted to forests and managed as such; this would be no doubtful experiment, would interfere with nobody, would enhance the value of the surrounding country—and education, example, and encouragement are provided, as far as it is in the legitimate province of the General Government. And such example, instead of costing anything to the country, can be made self-sustaining—nay, productive—and would add appreciably to the people's wealth.

I have avoided introducing any sentiment in the treatment of this question, simply presenting its bearing upon a tangible basis; but it is, indeed, a question into the discussion of which sentiment of the highest order should enter; a problem in the solution of which we should be actuated by the grandest conceptions of our duty as citizens of this nation, as citizens of this world, with the solemn creed of one of our great naturalists (Frederick von Müller) before us:

"I regard the forests as a heritage given us by Nature, not for spoil or to devastate, but to be wisely used, reverently honored, and carefully maintained. I regard the forests as a gift intrusted to any of us only for transient care during a short space of time, to be surrendered to posterity again as an unimpaired property, with the increased riches and augmented blessings, to pass, as a sacred patrimony, from generation to generation."

THE DANGERS OF RECEIVERSHIPS.

By H. W. BARTOL.

PERHAPS no question of the day is exercising a more important influence on the investments of the country than this question of receiverships, and certainly none is of more importance to the investor in corporation securities, whether it be in their stocks or bonds; for, with the present readiness of our courts to appoint receivers on the slightest excuse, and to hold the properties indefinitely, no one can tell when his property may be taken out of his hands, nor, when so taken, how it will be administered. In fact, this readiness of the courts to appoint receivers, is taken advantage of to wreck corporations in the interest of one class of creditors to the injury of all others, and under it unscrupulous speculators have and are to-day using the mantle of justice to accomplish their ends.

But, as mere assertions prove nothing, it is the purpose of this article to review some of the results that have been reached by this means, not from the standpoint of a lawyer, but from that of a citizen, who has had some experience in this line. It is the view of the writer that the only excuse for a court stepping in to prevent creditors from enforcing their rights is that, *pending litigation to close up a corporation* and determine the exact rights of all creditors, the law will appoint receivers to conserve the property; in other words, the court will conserve the property as a whole, until it can determine just what are the rights and equities of all parties concerned, and then make a distribution accordingly, unless in the mean time the corporation shall be shown to be solvent. In the case of an assignee taking possession of an insolvent estate, the law prevents creditors from selling the property piecemeal, making it the duty of the assignee to dispose of it and distribute the proceeds equitably ; in fact, he may, with propriety go further : for instance, if part of the property in his charge was a warehouse, stored with goods, from which the roof were blown, there is no doubt he would be sustained in using funds in his hands to put on a new roof, as it is self-evident that such an expenditure is for the benefit of the creditors. The court may, if part of the estate is a factory filled with partly-finished goods, go further, and authorize the assignee to finish the same. But what would be thought of the assignee who went beyond this ; who used the funds in his hands not only to mend roofs and finish goods, but to build new mills ; who paid interest to some creditors and refused others ; who, in a word, treated the property as though it were his own ? Would he not be brought up with a sharp turn, and either displaced or made distinctly to understand that he was exceeding his authority, and would be held personally responsible ? And are not the duties of an assignee, and that of a court taking possession of an insolvent estate, essentially the same ? I think they are, and that our courts in the license they have allowed their officers, the receivers, have gradually but surely been drifting away from both the law and equity.

It is held that receivers' certificates are a lien preceding all mortgages, and were receivers restricted to the lines I have laid down, there would be some plausibility in the argument, as, if the money so raised were only used for what is absolutely essential to *conserve* the property, and is manifestly for the benefit of all, it may be just that all should bear the burden. But even this is an open question, as, what might be essential to a junior creditor, may not be so to one at the head of the line. For instance, in the case of a railroad, with a first mortgage of $5,000,000, and subsequent mortgages amounting to more than $100,000,000, it can hardly be claimed that the $5,000,000 would be imperiled were even so essential a thing as a bridge left unbuilt if it fell down, as it is plain, if the court use proper diligence in deciding the case, a decision must be reached, and a sale had before their margin of safety is gone, and by consequence it would seem but justice that receivers' certificates should only take rank as a lien *preceding the class of creditors who ask for the appointment of receivers ;* and that this would work no hardship is self-evident, as, if those certificates were not marketable and the work really essential, the next preceding class of creditors would, in their own interest, make the application ; it is true that the answer to this is that the trustees of all preceding mortgages are sometimes (perhaps always) notified of the application for permission to issue certificates, and that if they, as the official representatives of the mortgagees, do not object, the court has a right to suppose there is no objection to the certificates becoming a lien preceding their mortgages ; and while this is technically true, still it is unfortunately a fact that the average trustee will not act until compelled to do so by the bondholders, and frequently the first the latter know of the application is, that the certificates are issued and the damage done.

The next point to which I wish to call attention is the facility with which mortgage creditors may be injured by receiverships as at present conducted. For instance, in a large corporation in Pennsylvania, which had been for years in the hands of receivers, only going out of the custody of the court for a few months, to again return to it, the first set of receivers used the earnings of the company to purchase rolling-stock, which, when they were discharged, should have belonged to the company, but which, by a species of sophistication more legal than equitable, they managed to place in a car-trust, and when the court again took charge, the new receivers began their duties by issuing several millions of certificates, much of which money was used to pay debts contracted during the very few months the property was out of the hands of the court; and while these certificates are claimed to be a lien, ahead of the mortgages, some of this property was real estate which the mortgages did not cover.

Now, as regards the consistency of receivers, this very same corporation furnished a striking example, viz.: when the receivers first took charge, they insisted, despite many protests, on doing the following things:

1. Paying part of the principal and all of the interest on the floating debt.

2. Paying the guarantees on leased lines.

In reference to item No. 1, after much work, caused largely by the active opposition of the receivers, the court was persuaded to order that nothing should be paid on the principal, but allowed the continuance of payments of interest, the result being that a man who loaned the company, say, fifty per cent on its fifth mortgage, got his interest, while the holder of the first mortgage of the company would go without, and the holders of the subsequent mortgages get nothing, and have millions of coupons piled up ahead of them; and in this connection it would be well to take note of the peculiar preference our courts give to creditors who loan on collateral security, paying them interest when all others are refused, and allowing them to sell, no matter at what sacrifice to the debtor, the collaterals in their hands, while other creditors with equal if not superior rights are not allowed to enforce theirs.

In reference to item No. 2, we find these same receivers coming into court and protesting that they must pay the rentals of leased lines, no matter who suffers, and the next year not only refusing to pay some of these rentals, but, in some cases, asking permission to abandon the lines altogether.

But perhaps the most startling anomaly will be found in the case of two large corporations, one in Pennsylvania and the other in New Jersey, and both in the hands of the same court, where we find the receivers, in one instance, paying the interest on all their bonds, and neglecting to pay the over-due principal on their car-trusts, while the other company defaults on all its bonds, and pays both principal and interest of its car-trusts. One of these decisions is probably right, but it does not require a lawyer to decide that both can not be, especially as in both cases the officials testified that the equipment was essential to its operation. Then, again, for some reason or other—probably that their jurisdiction extends over more than one State—most of the applications for receivers are made in the United States courts, perhaps, as in a recent instance, on the application of a man to whom the company owe a few thousands, when we have the ridiculous condition of affairs that those owning millions of the property, and even the trustees of the mortgages, have no legal status before the tribunal that is managing their property, because they, being citizens of the State in which the company has its domicile, have no standing in a Federal court, and, even did they have such standing, it is extremely difficult to get a court to find fault with or dismiss a receiver, firstly, because the receiver, being in possession of the books, it is difficult to get the evidence to show incapacity or misdoing, and, secondly, because for the court to do so would be to admit that it had erred in selecting the receiver, which courts, being human, do not like to do.

There is another danger about receiverships, viz.: if receivers are allowed to pay interest on floating debt, and continue payments to guaranteed and leased lines while defaulting on the securities of their own company, it can readily be seen that no better means could well be devised for unscrupulous men to wreck corporations, as all they have to do is to get themselves elected directors, make a few bad leases, loan the company's money to make gaudy reports until they sell their stock; then apply for a receiver, continue to pay the leased lines, until they freeze everybody out, and then, when they have bought in the securities at their own figures, sell out the property, and thus cancel the bad leases. Unfortunately, just this practice is the one by which some of the largest fortunes of the day have been made, and that it is well understood, the following remark of a prominent Wall Street operator will show, who said to a bondholder of a company that was in the hands of a receiver, "If you don't let us reorganize this property to suit the stockholders, we will keep it in the hands of the court for seven years!" If the court managed it well and fairly to all interests, the threat would have amounted to nothing; but, as some years of experience had shown just the contrary, it was a serious matter, and the bondholders had to yield, feeling that the terms, hard and unjust as they were, were preferable to further management by the court.

It will probably be asked, What is the cure for these troubles? which I confess is not so easy to answer; but I think the adoption of the following would go far to help matters:

1. Receivers' certificates should only take rank as a lien preceding the class of creditors on whose application the receivers are appointed, and should *only* be issued to raise money to conserve the property, and *not for betterments.*

2. As soon as receivers are appointed, the court should call a meeting of the mortgage creditors, to learn if the receiver selected is satisfactory.

3. The court should see that all proceedings under which receivers are appointed are prosecuted to an end with the utmost diligence, and, failing this, at once discharge the receivers.

4. As it is evident that our courts, as at present constituted, have neither the time nor the ability to manage large corporations, and hence must rely on their officers, the receivers, there should be a new court, part of whose judges should be business men, to whom all such applications should be made.

5. The protection of this court should extend to collaterals of the insolvent debtor which are pledged for loans, as there is no good reason why this class of creditors should be allowed to sacrifice the property of the debtor when all others are stopped.

It is not intended in this article to reflect on the judiciary, who probably have done the best they could under circumstances really foreign to their training and duties, and who have naturally left matters pretty much to their officers, the receivers; nor is it meant to imply that, in some cases, the timely protection of the court has not been of great advantage to the creditors; but when, as in the case of the Logansport, Crawfordsville, and Southwestern Railroad Company, we see the first-mortgage bondholders deprived of the management of their property, and it so loaded with receivers' certificates that when it is sold they swallow up every cent; when, as in the case of the Vicksburg and Meridian Railroad Company, we find the receiver not only buying new rails, but changing the gauge of the whole line; when, in cases nearer home, we find receivers using the bondholders' money to pay leased lines, and issuing car-trusts to increase the equipment, is it not time to call a halt, and ask both the courts and the people to consider what they are doing?

General Tillo has pointed out, in "Petermann's Mittheilungen," how the idea of a great world-water-parting may be worked out from a consideration of the earth's surface. He has laid down on a polar projection-map, showing both the Old and New World Continents, in illustration of his proposition, a single continuous line, broken only by Bering Strait, extending from the south point of America north along the west side of South and North America, in an irregular diagonal across Asia to the Isthmus of Suez, and down Eastern Africa to the Cape. General Tillo, however, admits that there are special continental water-partings which do not quite conform to the line of the great parting, although, as a matter of fact, nearly all the great rivers of the world are divided by this parting into two directions.

A GREAT LESSON.

BY THE DUKE OF ARGYLL.

THE most delightful of all Mr. Darwin's works is the first he ever wrote. It is his "Journal" as the Naturalist of H. M. S. Beagle in her exploring voyage round the world from the beginning of 1832 to nearly the end of 1836. It was published in 1842, and a later edition appeared in 1845. Celebrated as this book once was, few probably read it now. Yet in many respects it exhibits Darwin at his best, and if we are ever inclined to rest our opinions upon authority, and to accept without doubt what a remarkable man has taught, I do not know any work better calculated to inspire confidence than Darwin's "Journal." It records the observations of a mind singularly candid and unprejudiced—fixing upon Nature a gaze keen, penetrating, and curious, but yet cautious, reflective, and almost reverent. The thought of how little we know—of how much there is to be known, and of how hardly we can learn it—is the thought which inspires the narrative as with an abiding presence. There is, too, an intense love of Nature and an intense admiration of it, the expression of which is carefully restrained and measured, but which seems often to overflow the limits which are self-imposed. And when man, the highest work of Nature, but not always its happiest or its best, comes across his path, Darwin's observations are always noble. "A kindly man moving among his kind" seems to express his spirit. He appreciates every high calling, every good work, however far removed it may be from that to which he was himself devoted. His language about the missionaries of Christianity is a signal example, in striking contrast with the too common language of lesser men. His indignant denunciation of slavery presents the same high characteristics of a mind eminently gentle and humane. In following him we feel that not merely the intellectual but the moral atmosphere in which we move is high and pure. And then, besides these great recommendations, there is another which must not be overlooked. We have Darwin here before he was a Darwinian. He embarked on that famous voyage with no preconceived theories to maintain. Yet he was the grandson of Dr. Erasmus Darwin—a man very famous in his day, who was the earliest popular exponent of evolution as explaining the creative work, and who, both in prose and verse, had made it familiar as at least a dream and a poetic speculation. Charles Darwin in his "Journal" seems as unconscious of that speculation as if he had never heard of it, or was as desirous to forget it as if he concurred in the ridicule of it which had amused the readers of the "Anti-Jacobin." Only once in the "Journal" is there any allusion to such speculations, and then only to the form in which they had been more scientifically clothed by the French naturalist Lamarck. This is all the more curious and interesting, since here and there Charles Darwin records some facts, and enters upon some reasoning, in which we can now see the undeveloped germs of the theory which ultimately took entire possession of his mind. But that theory was, beyond all question, the later growth of independent observation and of independent thought. He started free—free at least, so far as his own consciousness was concerned. The attitude of his mind was at that time receptive, not constructive. It was gathering material, but it had not begun to build. It was watching, arranging, and classifying facts. But it was not selecting from among them such as would fit a plan. Still less was it setting aside any that did not appear to suit. He might have said with truth that which was said by a greater man before him, "*Hypotheses non fingo.*" This is one of the many great charms of the book.

And yet there was one remarkable exception. Like every other voyager who has traversed the vast Southern Ocean, he was struck, impressed, and puzzled by its wonderful coral reefs, its thousands of coral islands, and its still more curious coral "atolls." Why is it that so many of the continents and of the great continental islands whose coasts front or are surrounded by the waters of the Pacific, are fringed and protected by barrier-reefs of coral? The curious question that arises is not why the coral should grow at all, or how it grows. All this, no doubt, is full of wonder—wonder all the greater the more we know of its structure and of the nature of its builder. But let the growth of corals in seas of a certain depth and temperature be assumed and passed over, as we do assume and pass over a thousand other things with which we are familiar. The puzzle here is, why it should grow in the form of a linear barrier along a coast, and yet not touching it, but at a distance more or less great—sometimes very great—and always leaving between it and the land an inclosed and protected space of water which, once they have found an entrance through the reef, ships can navigate for hundreds of miles. Why should this same curious phenomenon be repeated on a smaller scale throughout the thousands of islands and islets which dot the immense surfaces of the Pacific? Why should these islands so often be the center of a double ring—first a ring of calm and as it were inland water, then a ring of coral reef fronting the outer sea, and lastly the ocean-depths out of which the coral reef rises like a wall? Why should this curious arrangement repeat itself in every variety of form over thousands of miles until we come to that extreme case when there is no island at all except the outer ring of the coral reef and an inner pool or lake of shallower water which is thus secluded from the ocean, with nothing to break its surface—shining with a calm, splendid, and luminous green, set off against the deep purple blues of the surrounding sea? For effects so uniform or so analogous, repeated and multiplied over an area so immense, there must be some physical cause as peculiar as its effects. Moreover, this cause must be one affecting not merely or only the peculiarities of the animal which builds up the coral, but some cause affecting also the solid rocks and crust of the earth. The coral animals must build on some foundation. They must begin by attaching themselves to something solid. Every coral reef, therefore, whatever be its form—every line of barrier-reef however long—every ring however small or however wide, must indicate some corresponding arrangement of subjacent rock. What cause can have arranged the rocky foundations of the coral in such curious shapes? Extreme cases of any peculiar phenomenon are always those which most attract attention, and sometimes they are the cases which most readily suggest an explanation. Ring-shaped islands of such moderate dimensions that the whole of them can be taken in by the eye, supply such cases. There are atoll-islands where ships can enter, through some break in the ring, into the inner circle. They find themselves in a perfect harbor, in a sheltered lake which no wave can ever enter, yet deep enough and wide enough to hold all the navies of the world. Round about on every side there are the dazzling beaches which are composed of coral sand, and crowning these there is the peaceful cocoanut-palm, and a lower jungle of dense tropical vegetation. On landing and exploring the woods and shores, nothing can be seen but coral. The whole island is a ring of this purely marine product ; with the exception of an occasional fragment of pumice-stone, which having been floated over the sea from some distant volcanic eruption, like that of Krakatoa, here disintegrates and furnishes clay, the most essential element of a soil. But reason tells us that there must be something else underground, however deeply buried. When the corals first began to grow, they must have found some rock to build upon, and the shape of these walls must be the shape which was thus determined. One suggestion is obvious. Elsewhere all over the globe there is only one physical cause which determines rocky matter into such ring-like forms as these, and which determines also an included space of depth more or less profound. This physical cause is the eruptive action of volcanic force. When anchored in the central lagoon of a coral atoll, are we not simply anchored in the crater of an extinct volcano—its walls represented by the corals which have grown upon it, its crater represented by the harbor in which our ship is lying ? The vegetation is not difficult to account for. The coral grows until it reaches the surface. It is known to flourish best in the foaming breakers. These, although confronted and in the main resisted by the wondrous tubes and cells, are able here and there in violent storms to break off the weaker or overhanging portions of the coral and dash them in fragments upon the top of the reef. Often the waves are loaded with battering-rams in the shape of immense quantities of drift-timber. These bring with them innumerable seeds and hard nuts able to retain their vitality while traversing leagues of ocean. Such seeds again find lodgment among the broken corals, and among the decaying pumice. Under tropical heat and moisture, they soon spring to life. The moment a palm-tree rears its fronds, it is visited by birds—especially by fruit-eating pigeons—bringing with them other seeds, which are deposited with convenient guano. These in turn take root and live. Each new accession to the incipient forest attracts more and more numerous winged messengers from interminable archipelagoes, until the result is attained which so excites our admiration and our wonder, in the atoll-islands of the Pacific. All this is simple. But here as elsewhere it is the first step that costs. Are all atolls nothing more than the cup-like rings of volcanic vents? And if they are, can a like explanation be given for the barrier-reefs which lie off continental coasts, and where the crater-like lagoon of an atoll is represented only by a vast linear expanse of included and protected sea?

Here were problems eminently attractive to such a mind as that of Darwin. Vast in the regions they affect, complicated in the results which are presented, most beautiful and most valuable to man in the products which are concerned, the facts do nevertheless suggest some physical cause which would be simple if only it could be discovered. All his faculties were set to work. Analysis must begin every work of reason. Its function is to destroy—to pull to pieces. Darwin had to deal with some theories already formed. With some of these he had no difficulty. "The earlier voyagers fancied that the coral-building animals instinctively built up these great circles to afford themselves protection in the inner parts." To this Darwin's answer was complete. So far is this explanation from being true, that it is founded on an assumption which is the reverse of the truth. These massive kinds of coral which build up reefs, so far from wanting the shelter of a lagoon, are unable to live within it. They can only live and thrive fronting the open ocean, and in the highly aërated foam of its resisted billows. Moreover, on this view, many species of distinct genera and families are supposed instinctively to combine for one end; and of such a combination Darwin declares "not a single instance can be found in the whole of Nature." This is rather a sweeping assertion. In the sense in which Darwin meant it, and in the case to which he applied it, the assertion is probably, if not certainly, true. The weapon of analysis, however, if employed upon it, would limit and curtail it much. We can not, indeed, suppose that any of the lower animals, even those much higher than the coral-builders, have any consciousness of the ends or purposes which they or their work subserve in the great plan of Nature. But Darwin has himself shown us, in later years, how all their toil is co-operant to ends, and how not only different species and families, but creatures belonging to different kingdoms, work together most directly, however unconsciously, to results on which their common life and propagation absolutely depend. In the case before us, however, this second objection of Darwin is superfluous. The first was in itself conclusive. If the reef-building corals can not live in a lagoon, or in a protected sea, it is needless to argue further against a theory which credits them with working on a plan to insure not their own life and well-being, but their own destruction.

But next, Darwin had to encounter the theory that atoll-islands were built upon extinct volcanoes, and represented nothing but the walls and craters of these well-known structures. This he encountered not with a sweeping assertion, but with a sweeping survey of the vast Pacific. Had those who believed in this theory ever considered how vast that island-bearing ocean was, and how enormous its supposed craters must have been? It was all very well to apply some known cause to effects comparable in magnitude to its effects elsewhere. The smaller atolls might possibly represent volcanic craters. But what of the larger? And what of the grouping? Could any volcanic region of the terrestrial globe show such and so many craters as could correspond at all to the coral islands? One group of them occupies an irregular square five hundred miles long by two hundred and forty broad. Another group is eight hundred and forty miles in one direction, and four hundred and twenty miles in another. Between these two groups there are other smaller groups, making a linear space of more than four thousand miles of ocean in which not a single island rises above the level of true atolls—that is to say, the level up to which the surf can break and heap up the coral masses, and to which the winds can drift the resulting sands. Some atolls seem to have been again partially submerged—"half-drowned atolls," as they were called by Captain Moresby. One of these is of enormous size—ninety nautical miles along one axis, and seventy miles along another. No such volcanic craters or mountains exist anywhere else in our world. We should have to go to the airless and waterless moon, with its vast vents and cinder-heaps, to meet with anything to be compared either in size or in distribution. And then, the linear barrier-reefs lying off continental coasts and the coasts of the great islands are essentially the same in character as the encircling reefs round the smaller islands. They can not possibly represent the walls of craters, nor can the long and broad sheltered seas inside them represent by any possibility the cup-like hollows of volcanic vents.

These theories being disposed of, the work of synthesis began in Darwin's mind. He sorted and arranged all the facts, such as he knew them to be in some cases, such as he assumed them to be in other cases. Above all, like "stout Cortes and his men," from their peak in Darien, "he stared at the Pacific." The actual seeing of any great natural phenomenon is often fruitful. It may not be true in a literal sense that, as Wordsworth tells us, "Nature never did betray the heart that loved her." But it is true that sometimes she discloses her secrets to an earnest and inquiring gaze. Sometimes things actually are what they look to be. Outwardly they are what their image on the retina directly paints them; and in their history and causes they may be what that image suggests not less directly to the intellect and the imagination. So Darwin, one day, standing on a mountain from which he commanded a wide space of sea, looked down upon an atoll with its curious ring of walled-in water, calm, green, and gleaming in the middle of the oceanic depths of blue. Did it not look as if there had once been an island in the middle? Did it not look as if the coral ring had been built up upon the rocky foundation of its former shores? Did it not look as if, somehow, this island had been removed, and the encircling reef had been left alone? Somehow! This could not satisfy Darwin. How could such an island be removed? Its once fringing and encircling reef would have protected it from the devouring sea. Did it not look as if it had simply sunk? Subsidence! Was not this the whole secret? The idea took firm hold upon his mind. The more he thought of it, the more closely it seemed to fit into all the facts. The coral-fringing reef of the island would not subside along with its supporting rocks, if that subsidence took place slowly, because the coral animals would build their wall upward as fast as their original foundation was sinking downward. And was there not a perfect series of islands in every stage of the suggested operation? There were islands with coral reefs still attached to their original foundations, islands with fringing reefs adhering to them all round, and leaving no lagoons. There were others where the foundations had sunk a little, but not very much, leaving only shallow and narrow spaces of lagoon-water between the island and the barrier-reef. Others there were again where the same process had gone further, and wide and deep lagoons had been established between the reef and the subsiding island. Then there were every variety and degree of the results which must follow from such a process, until we come to the last stage of all, when the island had wholly sunk, and nothing remained but the surviving reef—a true atoll—with its simple ring of coral and its central pool of protected water. Then further it could not but occur to Darwin that the objection which was fatal to the volcano theory was no difficulty in the way of his new conception; on the contrary, it was in strict accordance with that conception. The vast linear reefs lying off straight and continental coasts, which could not possibly represent volcanoes, were completely explained by a vast area of subsiding lands. The reefs were linear because the shores on which they had begun to grow had been linear also. The immense areas of sheltered sea, from twenty to seventy miles in breadth, which often lie between the barrier-reefs and the existing shores, for example, of Australia and New Guinea, were explained by the comparatively shallow contours of land which had gradually subsided and had left these great spaces between the original fringing reef and the existing shores. The more Darwin pondered, the more satisfied he became that he had found the clew. The cardinal facts were carefully collated and compared. First, there was the fact that the reef-building corals could not live at any greater depth than from twenty to thirty fathoms. Secondly, there was the fact that they can not live in water charged with sediment, or in any water protected from the free currents, the free winds, and the dashing waves of the open and uncontaminated sea—that vast covering of water which in the southern hemisphere is world-wide and world-embracing. Thirdly, there was the fact that the coral reefs rise suddenly like a wall out of oceanic depths, soundings of a thousand fathoms and more being constantly found close up to the barrier-reefs. Fourthly, there is the fact that on the inner side, next the island or the continent which they inclose or protect, the lagoon or the sheltered area is often very deep close to the reef, not indeed affording oceanic soundings, but nevertheless soundings of twenty to thirty fathoms. All these facts are indisputably true. Taking them together, the conclusions or inferences to which they point may well seem inevitable. Let us hear how Darwin himself puts them in the short summary of his theory which is given in the latest edition of his "Journal":

> From the fact of the reef-building corals not living at great depths, it is absolutely certain that throughout these vast areas, wherever there is now an atoll, a foundation must have originally existed within a depth of from twenty to thirty fathoms from the surface. It is improbable in the highest degree that broad, lofty, isolated, steep-sided banks of sediment arranged in groups and lines hundreds of leagues in length, could have been deposited in the central and profoundest parts of the Pacific and Indian Oceans, at an immense distance from any continent, and where the water is perfectly limpid. It is equally improbable that the elevatory forces should have uplifted throughout the above vast area, innumerable great rocky banks within twenty to thirty fathoms, or one hundred and twenty to one hundred and eighty feet, of the surface of the sea, and not one single point above that level; for where on the face of the whole globe can we find a single chain of mountains, even a few hundred miles in length, with their many summits rising within a few feet of a given level, and not one pinnacle above it? If then the foundations, whence the atoll-building corals sprang, were not formed of sediment, and if they were not lifted up to the required level, they must of necessity have subsided into it; and this at once solves the difficulty. For as mountain after mountain, and island after island, slowly sank beneath the water, fresh bases would be successively afforded for the growth of the corals.

So certain was Darwin of these conclusions that he adds, in a most unwonted tone of confidence:

> I venture to defy any one to explain in any other manner how it is possible that numerous islands should be distributed throughout vast areas—all the islands being low, all being built of corals, absolutely requiring a foundation within a limited depth from the surface.*

* "Journal," p. 468.

The voyage of the Beagle ended in the autumn of 1836, and Darwin landed in England on the 2d of October. He proceeded to put into shape his views on the coral islands of the Pacific, and in May, 1837, they were communicated to the public in a paper read before the Geological Society of London. His theory took the scientific world by storm. It was well calculated so to do. There was an attractive grandeur in the conception of some great continent sinking slowly, slowly, into the vast bed of the Southern Ocean, having all its hills and pinnacles gradually covered by coral reefs as in succession they sank down to the proper depth, until at last only its pinnacles remained as the basis of atolls, and these remained, like buoys upon a wreck, only to mark where some mountain-peak had been finally submerged. Besides the grandeur and simplicity of this conception, it fitted well into the Lyellian doctrine of the "bit-by-bit" operation of all geological causes—a doctrine which had then already begun to establish its later wide popularity. Lyell had published the first edition of his famous "Principles" in January, 1830—that is to say, almost two years before the Beagle sailed. He had adopted the volcanic theory of the origin of the coral islands; and it is remarkable that he had nevertheless suggested the idea, although in a wholly different connection, that the Pacific presented in all probability an area of subsidence. Darwin most probably had this suggestion in his mind when he used it and adopted it for an argument which its author had never entertained.* However this may be, it must have prepared the greatest living teacher of geology to adopt the new explanation which turned his own hint to such wonderful account. And adopt it he did, accordingly. The theory of the young naturalist was hailed with acclamation. It was a magnificent generalization. It was soon almost universally accepted with admiration and delight. It passed into all popular treatises, and ever since for the space of nearly half a century it has maintained its unquestioned place as one of the great triumphs of reasoning and research. Although its illustrious author has since eclipsed this earliest performance by theories and generalizations still more attractive and much further reaching, I have heard eminent men declare that, if he had done nothing else, his solution of the great problem of the coral islands of the Pacific would have sufficed to place him on the unsubmergeable peaks of science, crowned with an immortal name.

And now comes the great lesson. After an interval of more than five-and-thirty years the voyage of the Beagle has been followed by the voyage of the Challenger, furnished with all the newest appliances of science, and manned by a scientific staff more than competent to turn them to the best account. And what is one of the many results that have been added to our knowledge of Nature—to our estimate of the true character and history of the globe we live

* Lyell's "Principles," eleventh edition, p. 595.

on? It is that Darwin's theory is a dream. It is not only unsound, but it is in many respects directly the reverse of truth. With all his conscientiousness, with all his caution, with all his powers of observations, Darwin in this matter fell into errors as profound as the abysses of the Pacific. All the acclamations with which it was received were as the shouts of an ignorant mob. It is well to know that the *plébiscites* of science may be as dangerous and as hollow as those of politics. The overthrow of Darwin's speculation is only beginning to be known. It has been whispered for some time. The cherished dogma has been dropping very slowly out of sight. Can it be possible that Darwin was wrong? Must we indeed give up all that we have been accepting and teaching for more than a generation? Reluctantly, almost sulkily, and with a grudging silence as far as public discussion is concerned, the ugly possibility has been contemplated as too disagreeable to be much talked about. The evidence, old and new, has been weighed and weighed again, and the obviously inclining balance has been looked at askance many times. But, despite all averted looks, I apprehend that it has settled to its place forever, and Darwin's theory of the coral islands must be relegated to the category of those many hypotheses which have indeed helped science for a time by promoting and provoking further investigation, but which in themselves have now finally "kicked the beam."

But this great lesson will be poorly learned unless we read and study it in detail. What was the flaw in Darwin's reasoning, apparently so close and cogent? Was it in the facts, or was it in the inferences? His facts in the main were right; only it has been found that they fitted into another explanation better than into his. It was true that the corals could only grow in a shallow sea, not deeper than from twenty to thirty fathoms. It was true that they needed some foundation provided for them at the required depth. It was true that this foundation must be in the pure and open sea, with its limpid water, its free currents, and its dashing waves. It was true that they could not flourish or live in lagoons or in channels, however wide, if they were secluded and protected from oceanic waves. One error, apparently a small one, crept into Darwin's array of facts. The basis or foundation on which corals can grow, if it satisfied other conditions, need not be solid rock. It might be deep-sea deposits if these were raised or elevated near enough the surface. Darwin did not know this, for it is one of his assumptions that coral "can not adhere to a loose bottom."* The Challenger observations show that thousands of deep-sea corals and of other lime-secreting animals flourish on deep-sea deposits at depths much greater than those at which true reef-building species are found. The dead remains of these deeper-living animals, as well as the dead shells of pelagic species that fall from the surface waters, build up submarine

* "Journal," edition 1852, p. 477.

elevations toward the sea-level. Again, the reef-building coral will grow upon its own *débris*—rising, as men, morally and spiritually, are said by the poet to do, "on stepping-stones of their dead selves to higher things." This small error told for much; for if coral could grow on deep-sea deposits when lifted up, and if it could also grow seaward, when once established, upon its own dead and sunken masses, then submarine elevations and not submarine subsidences might be the true explanation of all the facts. But what of the lagoons and the immense areas of sea behind the fringing reefs? How could these be accounted for? It was these which first impressed Darwin with the idea of subsidence. They looked as if the land had sunk behind the reef, leaving a space into which the sea had entered, but in which no fresh reefs could grow. And here we learn the important lesson that an hypothesis may adequately account for actual facts, and yet nevertheless may not be true. A given agency may be competent to produce some given effect, and yet that effect may not be due to it, but to some other. Subsidence would or might account for the lagoons and for the protected seas, and yet it may not be subsidence which has actually produced them.

Darwin's theory took into full account two of the great forces which prevail in Nature, but it took no account of another, which is comparatively inconspicuous in its operations, and yet is not less powerful than the vital energies, and the mechanical energies, which move and build up material. Darwin had thought much and deeply on both of these. He called on both to solve his problem. To the vital energy of the coral animals he rightly ascribed the power of separating the lime from sea-water, and of laying it down again in the marvelous structures of their calcareous homes. In an eloquent and powerful passage he describes the wonderful results which this energy achieves in constructing breakwaters which repel and resist the ocean along thousands of miles of coast. On the subterranean forces which raise and depress the earth's crust he dwelt—at least enough. But he did not know, because the science of his day had not then fully grasped, the great work performed by the mysterious power of chemical affinity, acting through the cognate conditions of aqueous solution. Just as it did not occur to him that a coral reef might advance steadily seaward by building ever-fresh foundations on its own fragments when broken and submerged, or that the vigorous growth of the reefs to windward was due to the more abundant supply of food brought to the reef-building animals from that direction by oceanic currents, so did it never occur to him that it might melt away to the rear like salt or sugar, as the vital energy of the coral animals failed in the sheltered and comparatively stagnant water. It was that vital energy alone which not only built up the living tubes and cells, but which filled them with the living organic matter capable of resisting the chemical affinities of the inorganic world.

But when that energy became feeble, and when at last it ceased, the once powerful structure descended again to that lower level of the inorganic, and subject to all its laws. Then, what the ocean could not do by the violence of its waves, it was all-potent to do by the corroding and dissolving power of its calmer lagoons. Ever eating, corroding, and dissolving, the back waters of the original fringing reef—the mere pools and channels left by the outrageous sea as it dashed upon the shore—were ceaselessly at work, aided by the high temperature of exposure to blazing suns, and by the gases evolved from decaying organisms. Thus the enlarging area of these pools and channels spread out into wide lagoons, and into still wider protected seas. They needed no theory of subsidence to account for their origin or for their growth. They would present the same appearance in a slowly-rising, a stationary, or a slowly-sinking area. Their outside boundary was ever marching farther outward on submarine shoals and banks, and ever as it advanced in that direction its rear ranks were melted and dissolved away. Their inner boundary—the shores of some island or of some continent—might be steady and unmoved, or it might be even rather rising instead of sinking. Still, unless this rising were such as to overtake the advancing reef, the lagoon would grow, and, if the shores were steady, it would widen as fast as the face of the coral barrier could advance. Perhaps, even if such a wonderful process had ever occurred to Darwin—even if he had grasped this extraordinary example of the "give and take" of Nature—of the balance of opposing forces and agencies which is of the very essence of its system, he would have been startled by the vast magnitude of the operations which such an explanation demanded. In its incipient stages this process is not only easily conceivable, but it may be seen in a thousand places and in a thousand stages of advancement. There are islands without number in which the fringing reef is still attached to the shore, but in which it is being "pitted," holed, and worn into numberless pools on the inner surfaces where the coral is in large patches dead or dying, and where its less soluble ingredients are being deposited in the form of coral sand. There are thousands of other cases where the lagoon interval between the front of the reef and the shores has been so far widened that it is taking the form of a barrier, as distinguished from a fringing reef, and where the lagoon can be navigated by small boats. But when we come to the larger atolls, and the great seas included between a barrier-reef and its related shores, the mind may well be staggered by the enormous quantity of matter which it is suggested has been dissolved, removed, and washed away. The breadth of the sheltered seas between barrier-reefs and the shore is measured in some cases not by yards or hundreds of yards, not by miles, but by tens of miles, and this breadth is carried on in linear directions, not for hundreds of miles, but for thousands. And yet there is one familiar idea in geology which might have helped Darwin, as it is much needed to help us even now, to conceive it. It is the old doctrine of the science long ago formulated by Hutton, that the work of erosion and of denudation must be equal to the work of deposition. Rocks have been formed out of the ruins of older rocks, and those older rocks must have been worn down and carried off to an equivalent amount. So it is here, with another kind of erosion and another kind of deposition. The coral-building animals can only get their materials from the sea, and the sea can only get its materials by dissolving it from calcareous rocks of some kind. The dead corals are among its greatest quarries. The inconceivable and immeasurable quantities which have been dissolved out of the lagoons and sheltered seas of the Pacific and of the Indian Ocean are not greater than the immeasurable quantities which are again used up in the vast new reefs of growing coral, and in the calcareous covering of an inconceivable number of other marine animals.

Here, then, was a generalization as magnificent as that of Darwin's theory. It might not present a conception so imposing as that of a whole continent gradually subsiding, of its long coasts marked by barrier-reefs, of its various hills and irregularities of surface, marked by islands of corresponding size, and finally of the atolls which are the buoys, indicating where its highest peaks finally disappeared beneath the sea. But, on the other hand, the new explanation was more like the analogies of Nature—more closely correlated with the wealth of her resources, with those curious reciprocities of service, which all her agencies render to each other, and which indicate so strongly the ultimate unity of her designs. This grand explanation we owe to Mr. John Murray, one of the naturalists of the Challenger expedition, a man whose enthusiasm for science, whose sagacity and candor of mind, are not inferior to those of Darwin, and whose literary ability is testified by the splendid volumes of "Reports" now in course of publication under his editorial care. Mr. Murray's new explanation of the structure and origin of coral reefs and islands was communicated to the Royal Society of Edinburgh in 1880,* and supported with such a weight of facts, and such a close texture of reasoning, that no serious reply has ever been attempted. At the same time, the reluctance to admit such an error in the great Idol of the scientific world, the necessity of suddenly disbelieving all that had been believed and repeated in every form, for upward of forty years—of canceling what had been taught to the young of more than a whole generation —has led to a slow and sulky acquiescence, rather than to that joy which every true votary of science ought to feel in the discovery of a new truth and—not less—in the exposure of a long-accepted error. Darwin himself had lived to hear of the new solution, and with that splendid candor which was eminent in him, his mind, though now

* "Proceedings of the Royal Society of Edinburgh," vol. x, pp. 505-518.

grown old in his own early convictions, was at least ready to entertain it, and to confess that serious doubts had been awakened as to the truth of his famous theory.

If, however, Mr. John Murray has not been cheered by the acclamations which greeted his illustrious predecessor, if the weight of a great accepted authority and of preconceived impressions has kept down the admiration which ought ever to reward the happy suggestions of laborious research, he has had at least the great satisfaction of observing the silence of any effective criticism. But more than this—he is now having the still greater satisfaction of receiving corroborative support from the observations of others. His own series of facts as ascertained during the voyage of the Challenger constituted an array of evidence tolerably conclusive. But since he read his paper in Edinburgh, an island has been discovered in the Solomon group by another naturalist, Dr. Guppy,* which lifts into the light and air a complete record of the series of operations beneath the waters of the Pacific to which Mr. Murray ascribes the origin of countless other islands, islets, and atolls. Here the barrier-reef and the atoll have been elevated from their bed, and all their foundations have been shown. Those foundations are not solid rock, but are just what Darwin assumed they could never be—deep-sea deposits. These had been originally, of course, laid down in more or less oceanic depths. But elevation, not depression, had begun the work. The deep deposit had ceased to be deep because the crust of the earth, on which it lay, had been bulged upward by subterranean force. The deep bottom had become a shoal, rising to the required distance from the surface-level of the sea. The moment it reached the thirty or the twenty fathom depth, the reef-building corals seized upon it as their resting-place, and began to grow. Possibly some process of induration may have affected the deposit before it reached this point. Probably it was consolidated or indurated by the luxuriant growth of myriads of deep-sea creatures at depths greater than thirty fathoms.

It has recently been discovered, by another naturalist of the Challenger school,† that there may be a special explanation of this part of the operation. It is found that shoals have the immediate effect of converting the tidal wave of deeper water into a current. This current sweeps off the looser deposits covering the shoal. Deep-sea corals then settle upon it. These may, and often do, build up their walls to a great height, and if this height reaches the zone of the true reef-building species, a firm basis is at once provided for their operations. Shoals have lately been discovered off the African coasts of the Atlantic, which in tropical seas would probably have become coral

* Surgeon of H. M. S. Lark. "Transactions of the Royal Society of Edinburgh," June, 1885.

† "On Oceanic Shoals discovered by the steamship Dacia," by J. Y. Buchanan, F. R. S. E., "Proceedings of the Royal Society of Edinburgh," October, 1883.

islands. This may or may not have been often the case in the Pacific. But it does not affect the question, except in so far as it may justify Darwin's conception that reef corals can not grow on "loose deposits." They may have ceased to be so soft and loose as they are when resting in the quiet depths of the thousand-fathoms sea. This induration may be part or an accompaniment of the process of elevation, but whether it be so or not the process is equally one of elevation and not of subsidence. In the island described by Dr. Guppy, the foundations of the reef-building corals are seen resting directly on the remains of the pelagic fauna, and both theories equally assume and assert the uncontested fact that these foundations when the coral wall began to grow must have been previously elevated to the requisite level, that, namely, of from one hundred and eighty to one hundred and twenty feet below the surface of the ocean. Mr. John Murray's explanation is fully confirmed that the coral reefs often begin on shoals; that these shoals are due to elevations of the sea-bottom; that the reef when once established can and does grow seaward upon its own fragments broken and submerged; that these form a "talus" capable of indefinite advance until the farthest limit of the shoal is reached; that the rearward ranks of the coral animals die as they are left behind in the hot and shallow waters of the lagoon; that their calcareous skeletons are then attacked by the solvent action of the water, are eaten away and carried off to form the materials of new reefs and the shells of countless other creatures. These have likewise been confirmed by the investigations of Mr. Alexander Agassiz in the West Indies. Often in the Pacific, as in all other regions of the earth, the elevating forces rest for ages, having done all the work which on some particular area they have got to do. The shoals remain shoals, only covered with the walls and battlements of coral. This is the case which accounts for countless islands never exceeding a certain height. On the other hand, and "otherwhere," the elevating forces, after a rest, resume their operation, lift up these coral walls and battlements wholly out of the sea, and make other islands by the thousand which become the delight of man; while in yet another class of cases the elevations open out into volcanoes, and constitute great areas of land which are among the most fertile regions of the habitable globe. But everywhere and always the ubiquitous coral animals fix on every shoal and on every shore whether old or new, and resume the wonderful cycle of operations in which they are a subordinate but a powerful agent.

In a recent article in this Review I had occasion to refer to the curious power which is sometimes exercised on behalf of certain accepted opinions, or of some reputed prophet, in establishing a sort of Reign of Terror in their own behalf, sometimes in philosophy, sometimes in politics, sometimes in science. This observation was received as I expected it to be—by those who, being themselves subject to this kind of terror, are wholly unconscious of the subjection. It is a remarkable illustration of this phenomenon that Mr. John Murray was strongly advised against the publication of his views in derogation of Darwin's long-accepted theory of the coral islands, and was actually induced to delay it for two years. Yet the late Sir Wyville Thomson, who was at the head of the naturalists of the Challenger expedition, was himself convinced by Mr. Murray's reasoning, and the short but clear abstract of it in the second volume of the narrative of the voyage has since had the assent of all his colleagues.*

Nor is this the only case, though it is the most important, in which Mr. Murray has had strength to be a great iconoclast. Along with the earlier specimens of deep-sea deposits sent home by naturalists during the first soundings in connection with the Atlantic telegraph cable, there was very often a sort of enveloping slimy mucus in the containing bottles which arrested the attention and excited the curiosity of the specialists to whom they were consigned. It was structureless to all microscopic examination. But so is all the protoplasmic matter of which the lowest animals are formed. Could it be a widely-diffused medium of this protoplasmic material, not yet specialized or individualized into organic forms, nor itself yet in a condition to build up inorganic skeletons for a habitation? Here was a grand idea. It would be well to find missing links; but it would be better to find the primordial pabulum out of which all living things had come. The ultra-Darwinian enthusiasts were enchanted. Haeckel clapped his hands and shouted out Eureka loudly. Even the cautious and discriminating mind of Professor Huxley was caught by this new and grand generalization of the "physical basis of life." It was announced by him to the British Association in 1868. Dr. William Carpenter took up the chorus. He spoke of "a living expanse of protoplasmic substance," penetrating with its living substance the "whole mass" of the oceanic mud.† A fine new Greek name was devised for this mother slime, and it was christened "Bathybius," from the consecrated deeps in which it lay. The conception ran like wildfire through the popular literature of science, and here again there was something like a coming *plébiscite*, in its favor. Expected imagination soon played its part. Wonderful movements were seen in this mysterious slime. It became an "irregular network," and it could be seen gradually "altering its form," so that "entangled granules gradually changed their relative positions."‡ The naturalists of the Challenger began their voyage in the full Bathybian faith. But the sturdy mind of Mr. John Murray kept its balance—all the more easily since he never could himself find or see any trace of this pelagic protoplasm when the dredges of the Chal-

* "Narrative of the Challenger Expedition," vol. i, p. 781.

† "Proceedings of the Royal Society," No. 107, 1868, pp. 190, 191.

‡ "The Depths of the Sea," second edition, London, 1874, pp. 410–415.

longer came fresh from bathysmal bottoms. Again and again he looked for it, but never could he discover it. It always hailed from home. The bottles sent there were reported to yield it in abundance, but somehow it seemed to be hatched in them. The laboratory in Jermyn Street was its unfailing source, and the great observer there was its only sponsor. The ocean never yielded it until it had been bottled. At last, one day on board the Challenger an accident revealed the mystery. One of Mr. Murray's assistants poured a large quantity of spirits of wine into a bottle containing some pure sea-water, when lo! the wonderful protoplasm Bathybius appeared. It was the chemical precipitate of sulphate of lime produced by the mixture of alcohol and sea-water. This was bathos indeed! On this announcement "Bathybius" disappeared from science, reading us, in more senses than one, a great lesson on "precipitation." *

This is a case in which a ridiculous error and a ridiculous credulity were the direct results of theoretical preconceptions. Bathybius was accepted because of its supposed harmony with Darwin's speculations. It is needless to say that Darwin's own theory of the coral islands has no special connection with his later hypotheses of evolution. Both his theory and the theory of Mr. Murray equally involve the development of changes through the action and interaction of the old agencies of vital, chemical, and mechanical change. Nevertheless, the disproof of a theory which was so imposing, and had been so long accepted, does read to us the most important lessons. It teaches us that neither the beauty—nor the imposing character—nor the apparent sufficiency of an explanation may be any proof whatever of its truth. And if this be taught us even of explanations which concern results purely physical, comparatively simple, and comparatively definite, how much more is this lesson impressed upon us when, concerning far deeper and more complicated things, explanations are offered which are in themselves obscure, full of metaphor, full of the pitfalls and traps due to the ambiguities of language—explanations which are incapable of being reduced to proof, and concern both agencies and results of which we are profoundly ignorant!—*Nineteenth Century*.

* "Narrative of the Challenger Expedition," vol. i, p. 939.

President Woodward, of Washington College, St. Louis, gave to the American Association an excellent account of the results of the manual training course at that institution. After three years of it, the boys could go out and succeed in any trade they entered; and their capacity and excellence were acknowledged by master-workmen. Professor E. J. James regarded the introduction of this branch as the next great step in the development of our educational system. It would give symmetry to our now one-sided and defective system of public instruction; would induce a better attendance at the schools; would remove all traces of stigma from labor, and gradually elevate the social tone of our workmen; and would aid in developing intellectual and industrial ability now lying dormant in thousands of our children.

THE COLOR OF WORDS.

By N. E. NEWELL.

THERE are some curious things in regard to the way in which the human mind is affected by colors as well as the human sight. We are all familiar with what is termed color-blindness, and the unexpected results that sometimes attend it; but color-sound is something which has received much less investigation.

How much, or in what way, animals are affected by colors, is not very well understood; but the subject has been investigated enough to know that they are influenced by them, and the future will probably bring out some surprising results to the one who shall thoroughly cultivate this comparatively unexplored field of research.

Some people can select and appreciate the colors of sounds; and to them the speaking of a name presents, mentally, a well-defined color, or combination of colors, different names having different shades or combinations.

The same name should, of course, always present the same color, or combination, when spoken, although, to different people, possessing the faculty, a given name or sound does not present the same characteristics. To prove the first of these two facts, a list of names was prepared, and the shade or color given by a lady who has this power, marked against each one of the list. After several weeks the names were again read to her, and the colors designated by her marked. This course was pursued several times during a year or more, the lady not being allowed to see the results in that time. During these several experiments the only variations in the answers given were such as would be natural where there was some uncertainty in regard to terms: for example, the answer to a given name at one time might be, "bluish," and at another, "lead-color"; so, what was called "straw-color" might be afterward called "buff." The approach to similarity in the shades shows that the same mental picture was present, and only language was at fault.

With one or two exceptions these were the only changes noted in the several trials; and the extent to which the experiments were carried warrants the belief that there was a well-defined idea of the color of words.

A few years ago a New York physician had two patients that probably had this faculty of the mind abnormally developed: one had a horror of all words in which the letters *ch* were placed; and the other was taken with hysterics at a certain shade of blue. Whether or not the latter case has any bearing on the subject, may be questioned; but it seems as though a perception so acute in regard to certain colors would involve the power of word-coloring.

Following are the words and the colors assigned to them in the experiments noted above, including a few double numbers: 1, black; 2, light-cream; 3, dark-cream; 4, brownish-red; 5, black; 6, tan-color or cream; 7, greenish-black; 8, dark-straw; 9, mud-color; 10, black; 21, black and straw; 22, light-cream; 23, dark straw-color; 24, light and brown.

Some three years ago Professor E. S. Holden contributed a paper to "Science" on "Visualized Numbers," in which examples were given that differ in some points from the results obtained by the writer. For the purpose of comparing, I quote from Professor Holden's article: "1, black; 2, cream; 3, blue; 4, brown; 5, white; 6, crimson-pink; 8, white; 9, greenish; 10, brown."

It will be seen that where there is a variation it is a radical one. I do not attempt to explain the reason, but state it as a curious example of mental idiosyncrasy.

Following some familiar names are given, and the color of each, and also the letters of the alphabet: Mary, dark-red; Abbie, tan; Lucy, dark-blue; Richard, light-gray; Atalanta, steel-gray; Charlotte, light-red; Claire, light-blue; Newcomb, dark-red; Lincoln, black; Morse, brown; Newhall, gray-black; Frank, dark-green; A, light-straw; B, gray; C, tan; D, blue; E, black; F, black; G, light-straw; H, red; I and J, black; K, blue; L, black; M, brown; N, dark-blue; O, light-red; P, light-green; Q, blue; R and S, light-straw; T, green; U, gray; V, yellow; W, blue; X, gray; Y and Z, dark-brown.

"Color-hearing" has been considered in "The Popular Science Monthly" [August, 1883]. I quote from the article: "There are, in fact, persons who are endowed with such sensibility that they could not hear a sound without at the same time perceiving colors." These are the colors of sounds, and the sound of colors is what can be regarded as another branch of the same scientific mystery. Dr. Sophus Trombolt has investigated in this direction and according to the testimony of one hundred and forty-four persons in Norway in relation to the emission of sound by the northern lights, ninety-two were found who believed in such sounds, and fifty-three asserted that they had heard them. The sound was described as sizzling, hissing, whizzing, crackling, rushing, rippling, rolling, flapping, creaking, and roaring.

[Note by the Editor.—Connected with this subject it may be well to recall an interesting relation of experiences which was started several years ago by Mr. Francis Galton, respecting what he designated "visualized numerals," and the association of colors with various numbers. The term "visualized numerals" in its simplest sense means the conception, or mental vision, when any number is spoken or thought of, of that number as it is written, the power to form which may extend in some cases to lines of considerable length. In a fuller sense the term means more, and may be associated with very curious shapes and orders in which the digits or numbers arrange themselves, of which a considerable variety have been described by Mr. Galton and his correspondents, and by M. Jaques Bertillon. One correspondent reported to Mr. Galton that when a child he counted by imaginary cards from one to ten, and his little boy in the same way used an imaginary domino ; another pictured numbers in groups of so many dots ; to the same person, the numbers, from the part they played in the multiplication-table, had been personified. Thus, 9 was a wonderful being of whom he felt almost afraid ; 8 was his wife ; "and there used always to seem a fitness in 9×9 being so much more than 8×8" ; 7 was masculine ; 6, of no particular sex, but gentle and straightforward ; 3, a feeble edition of 9, and generally mean ; 2, young and sprightly ; 1, a commonplace drudge. "In this style the whole multiplication-table consisted of the actions of living persons, whom I liked and disliked, and who had, though only vaguely, human forms." Mr. George Bidder, who was known in early life as "the calculating-boy," saw the numbers arranged in their order along a concavely-scalloped curve, the first part of which, comprising the first ten numbers, followed the arrangement of figures on a clock-face.

Another person's experience was to see the numbers arranged in association with certain colors up to 108. After 108 the notion of place became hazy and indistinct, though visualization was still possible, with effort. This writer as a child had a great liking for 6, arising, possibly, from his desire to be six years old. He was also very fond of blue, the color which he associated with 6. One of this writer's sisters saw numerals in a differently arranged diagram, and the figures themselves colored, each its own color. Another sister and a brother saw the figures in diagrams, but less clearly. The effects of heredity were strongly marked in two families of cousins. A sister in the first family saw the figures up to 200 in a rather complicated arrangement in a kind of cloud-land of different degrees of shading; another sister saw them ascending in a directly perpendicular line in front of the eye up to 1,000, when they became vague and seemed to turn to the left. A brother saw them in a straight line from left to right, black, on a ground varying in illumination—the millions in a vague, bright distance to the right. Other members of these families associated them with figures or with linear arrangements peculiar to themselves.

To another writer the figures presented themselves in an intricate curve, in which "the zero-point never moves ; it is *in* my mind ; it is that point of space known as 'here,' while all other points are outside, or 'there.' When I was a child, the zero-point began the curve ; now it is a fixed point in an infinite circle." To another, who saw the numerals arranged for the most part in a regular row, like park palings, they appeared as far as 12 to be concealed in black shadow ; from 12 to 20 was illuminated space, in which he could distinguish no divisions.

A person who was described as a mathematical astronomer, of rapidly-rising reputation, saw the numbers in a straight row, while he would be standing a little on one side. They went away in the distance, so that 100 was the farthest number be could see distinctly. The row was dusky-gray, and paler near to the observer. The tens were marked by a kind of fleecy lumps.

M. d'Abbadie made a communication on the peculiarities of numerical vision to the Anthropological Society of Paris, and this led M. Jaques Bertillon to relate his experiences in the matter, beginning with the time when he learned to count. "I connected," he says, "each of the numbers as it was taught me with some object in our garden, so that when I went over the series I would in imagination walk along an alley that led from the house to the end of the garden. Thus, an indestructible association of ideas arose between the figures and the plants in the garden: the figure 1 became attached to a chestnut-tree that marked the beginning of the walk, the figure 5 to a bench near it, the figure 7 to a tub farther on, the number 14 to a little laurel; 30 and the following figures were lost in a dark avenue of trees that terminated the walk; while beyond 40 the numbers ceased to be associated with any object, probably because I had not learned to count further when I made the pleasant associations. If I wished to add 14 and 5, I would in fancy go to the place (the laurel-bush) that 14 occupied in the garden, and go some steps farther to 19. The puerile work was wholly involuntary; and I well recollect when my tendency to proceed thus was almost invincible. I had another process for fractions: the idea of $\frac{1}{4}$, for example, was directly associated with the idea of a quarter of an hour marked on the clock; and if I had to add $\frac{1}{4}$ and $\frac{1}{3}$, I imagined the hand pushed forward twenty minutes, or one third of an hour, and I immediately had the result, $\frac{7}{12}$. I was not able, however, to calculate any fractions in this way the denominators of which were not factors of 60."

A professor of mathematics in Geneva saw the numbers in a zigzag line which made turns at 10 and at 60, up to 116, and no further, and added to his description that when young he likened some sounds to colors: a grave sound was black, a less grave one, red; an acute sound, yellow; a very acute one, bright yellow.

Another correspondent saw the numbers arranged in their regular orders in a system of lines—the first 10 in a horizontal line, the next 10 in a line perpendicular to it, the third 10 in a line running diagonally from right to left, the numbers from 30 to 90 in a perpendicular line parallel to the line of the second series, and the larger numbers to 1,000 in a line running from right to left parallel with the first one. The vision stopped at 1,000.

To another correspondent of M. Bertillon's the numbers presented themselves—not very clearly distinct from one another—in a descending column, quite narrow down to 10, where it doubled in width;

from 16 to 20 the column swelled out till it formed a rectangle twice as broad as the double column from 10 to 16; passing 20, the column narrowed again, changed direction, and ascended perpendicularly, but in such a way that it was impossible to tell how the new column was connected with the former descending column; but it went up, whatever might be the fate of the other column, presenting its rectangular swelling at every 10. Passing 50, it curved to the right, still retaining its dimensions and its swelling at every 10, then descended in a curve to 100, where the vision stopped.

All of the seers so far quoted had the numbers presented to them in a plane. One other one described his vision as that of an arrangement around the three sides of a triangular prism. On the first face appeared the first 30 numbers, running in a zigzag line, 10 and 30 being seen at apical angles, 20 at a depressed angle; on the second face the numbers from 30 to 100 ran in a straight horizontal line; and on the third face those from 100 to 1,000 in a straight ascending line. The spiral returning to the first face of the prism, the numbers from 1,000 to 30,000 appeared upon it in a zigzag line parallel to the first line of 1 to 30. The second face again contained the numbers from 30,000 to 100,000, and the third face those from 100,000 to 1,000,000 in lines parallel to the other lines on the same faces.]

JOHN JACOB BAEYER.

By J. HOWARD GORE.

WHEN Frederick the Great, June 22, 1740, wrote, "In this country every man must get to heaven his own way," there were many sturdy Germans who were glad to embrace the opportunity to turn aside from the route to which the beliefs of their ancestors restricted them. But they did not wish to be alone upon the unknown sea into which their independence had launched them; every one felt the need of that encouragement which comes from the association of those whose aims and methods are the same. To secure this, the gracious sovereign allowed colonies to be formed of those of like faith and order. One of these colonies was Müggelsheim, about fourteen miles southeast of Berlin. Among the founders of this village there was a "faithful follower" who came from Odernheim seeking that religious sympathy which was here vouchsafed. This pilgrim sat as magistrate in the new settlement, while another coming from Mainz was the school-teacher; these two became connected by the former's son marrying the latter's daughter. On the 5th of November, 1794, this couple rejoiced over the birth of a son—JOHAN JACOB BAEYER. The first few years of the lad were uneventful; he watched the geese, herded the cattle, and laid, in healthful exercise, the foundation for a vigorous, active life. He was sent to the village school until he was thirteen years old. Here the pupil's talents were proudly observed and duly fostered by the teacher, his grandfather, who noticed especially the wonderful memory of the youth.

This capability seems to have been the moving cause that prompted the parents to give Baeyer the advantages of a better course of instruction. They sought to find this in the person of Gronau, the pastor in the neighboring town, Köpenick. Here he remained three years, going thence to the gymnasium in Joachimsthal, where he entered the fourth class.

Before completing the course here, the breaking out of the War of 1813 fired him with a thirst for military experience, which he obtained as a volunteer in the Third East Prussian Infantry, serving until the declaration of peace in 1814. He then returned to his gymnasium studies, to be again interrupted by the outbreak in 1815. The repeated inclinations to be a soldier were gratified by again enlisting in the army, this time as an officer in the Fourth Rhine militia. This life had a charm for him ; so, at the close of the war, he attended the military school at Coblenz, and in 1821, through the intervention of General von Müffling, who had become acquainted with Baeyer's predilection for geodetic work, he was detailed to the general staff.

It was at this time that Von Müffling was engaged upon the arc of longitude extending from Dunkirk, the extremity of the French arc of latitude, to Seeberg. In this work Baeyer assisted, especially in the computations, receiving in return his chief's ardent thanks in the preliminary report published in the "Astronomische Nachrichten," 1822, No. 27.

The year 1822 was perhaps a pivotal year to Baeyer. Just while comparing the life of a soldier with that of a scientist, at a time when he had obtained a place of honor in the military service, and had also been publicly thanked by a distinguished man for scientific work, he met Alexander von Humboldt and Bessel. The former was planning a second trip around the world for the purpose of collecting items of interest, and thought that he had found in this clever, energetic officer, now in his twenty-seventh year, the person to place in charge. The proposition was formally made, and so seriously considered that by way of preparation Baeyer attended the lectures of Weiss on mineralogy and geognosy during the two following years. For certain reasons the plan fell short of consummation, but Humboldt's friendship and example were always great incentives to his youthful friend. Bessel also followed the career of Baeyer with interest, and saw in later years that his talents and skill were of such character as to bring them together as co-workers, assisting one another. He was promoted to first lieutenant in 1823, and in the following year he was one of a party that made a survey of the Suwarrow route over the Alps, during which he ascertained, by means of a barometer, the altitudes of more than a hundred stations. Poggendorff paid him the compliment of discussing one of these determinations in "Annalen der Physic und Chemie," vol. ii, 1825, pp. 109–112.

In 1825 he was appointed a member of the faculty of the military school at Berlin, at first teaching pure and afterward applied mathematics; and from 1832 to 1857 he had charge of the department of geodesy, lecturing on the theory during the winter and working at it practically during the summer months. It was at the very beginning of his course in geodesy that Bessel secured his assistance in that monumental work, the degree-measurement in East Prussia, the results of which were published in 1838 under their joint authorship. While Bessel is known as the leading spirit in this undertaking, Baeyer's skill in handling instruments, his interest in base-measuring, and his efficiency in recognizance, contributed no little to its success. The accuracy, watchfulness, and painstaking detail of the enthusiastic officer stimulated Bessel to do his best; and this best so impressed itself upon Baeyer that posterity has become his debtor for having handed down and improved the methods of his honored master.

Before completing this work he received another call, this time through the intercession of Humboldt. The gravity experiments made by Bessel at the Berlin Observatory could not be of any especial value, owing to the uncertainty of the altitude of Berlin above sea-level, which at that time was known only from barometric observations. Trigonometric leveling was now coming into great favor, especially when the precaution was taken to make reciprocal zenith-distance observations. So, when it was ordered by the general staff in 1835 that the altitude of Berlin above the mean sea-level at Swinemünde should be determined, the execution of the order fell upon Baeyer, who, with the assistance of Bartram, finished it during the same summer. The result obtained differs only by a few decimetres from that recently found by a line of geodesic levels. At Swinemünde a permanent mark was established, and annually for several years the height of this above mean tide was measured; these records many years later disproved the theory that the Baltic Sea had been subjected to a great change during the first half of this century in height.

He was placed in charge of the survey of the coast of the Baltic Sea in 1837, the triangulation for which he joined to that of the degree-measurement chain. This was carried up to annexation with the Danish work. In 1843 he was made chief of the trigonometric branch of the general staff, when he continued his great coast-survey, bringing the triangulation from Stettin to Berlin, and also connecting with Müffling's chain. These nets, together with Tranchot's and others, executed earlier for the purpose, formed the basis for the land-survey of the Prussian states. Baeyer thought that work done at different times and by various persons should be brought into harmony by all resting upon the same basis; to which end he measured two bases, one at Berlin in 1846 and the other at Bonn in 1847. The results of the former were announced in 1849, but the necessity for reobserving some of the adjacent angles delayed the publication regarding the latter until 1876.

The coast-triangulation was so well executed that it was deemed advisable to utilize it in degree determinations by connecting it with the Russian system. This was done by Baeyer and General von Tenner from 1850 to 1851, with every precaution then known, including remeasurement of bases and a careful comparison of the standards. The difference in the total length of sixteen sides they had in common was only 0·505 metre.

His work occasionally overstepped the boundary-lines, establishing stations in other countries; these served as germs of larger growth, in many cases afterward nurtured by Baeyer's own hands. His advice was so frequently solicited, and when followed the results were so praised, as to induce him to prepare and submit to the Prussian Minister of War a memoir giving in detail a method for making a good map of Prussia. The principal improvement suggested, and afterward adopted, was in the more extensive use of triangulation, fixing in this way every point of importance, leaving but little intermediate ground to be located graphically.

His tastes for geodetic work were soon to be more fully gratified. Having passed rapidly through the lower grades, he was in 1858 made a lieutenant-general, and retired. It seems as though this eventual freedom to follow his own inclinations had in early life impressed itself upon him, for we find that in his work when he came to a station that at some future time might be of geodetic importance, he bestowed upon it especial care, supplementing the usual series of observations with those that would obviate the necessity of reoccupying it. Before indecision as to what should next receive his attention had become wearisome, Struve secured his co-operation in extending the Russian arc of longitude along the fiftieth parallel into Prussia. This he had in hand during 1858, making only astronomic observations, as it was his purpose to use the triangulation previously made. After several interruptions, owing to the withdrawal of the officers detailed to assist, he decided to make Rauenberg his central point, and to determine the direction of the chain by the azimuth of the line from this station to the Marien-Dom in Berlin—a line which now orients the entire Prussian survey.

The association with Müffling, Bessel, and Struve gave to Baeyer the incentive to connect and unify the excellent geodetic work of middle Europe; geographically, his native land occupied a favored place, and his government fostered the scheme. In 1861 the plan for a middle European degree-measurement, drawn up by Baeyer and sanctioned by the Minister of War, was approved by the emperor. At once the co-operation of the states that were to participate was requested, and to show the importance of such an undertaking, he published a pamphlet on the "Size and Figure of the Earth," giving an account of the geodetic work up to that time, and outlining what remained to be done under the auspices of the proposed commission. The permanent commission held its first session in Berlin in 1864, with Baeyer as president—a young organization with a leader aged seventy. The Prussian Geodetic Institute, established in 1869, was also placed under the direction of Baeyer. In both institutions he took an active part, not only in the official routine, but in making astronomic observations and comparing standards until 1874.

Under his instructions, the observations of Bessel at Königsberg in 1826, and Schumacher at Guldenstein in 1829, with the pendulum, were repeated, to see if the length of the seconds pendulum had retained the same relation to the toise. No change was found, showing that no alteration had taken place in the toise from molecular action, as had been feared.

As a careful observer, his attention was always directed toward possible sources of error in his work, especially toward atmospheric refraction, and, as connected with it, the physics of the atmosphere. He utilized all data obtainable from leveling for deducing a formula in which the coefficient of refraction could be given as a function of time or meteorologic conditions. The elaborated formula was published in 1840, and with revisions in 1860. He also conceived the application of the converse principle, from which observations for refraction would reveal the condition of the atmosphere. In addition to his purely practical discussions he wrote several articles upon winds, and the solutions of spheroidal triangles. He was an active or honorary member of the leading scientific societies at home and abroad; many decorations were conferred upon him by various crowned heads. On the 8th of January, 1883, he celebrated the seventieth anniversary of his connection with scientific work. And on the 6th of November of the following year, in honor of his ninetieth birthday, the Academy of Sciences of Berlin sent a deputation to carry their congratulations and good wishes; the Geodetic Institute presented him with a bust of himself, and the emperor and crown prince sent their compliments.

He brought his interest in scientific work down to his death-bed, on which, two days before his end, he was listening to the report of operations that he had shortly before planned and started. On September 10, 1885, the inflammation of the lungs, from which he had suffered only a few days, proved fatal.

NOTE.—While preparing this, I received from Dr. Helmert, Baeyer's successor as President of the Prussian Geodetic Institute, his sketch of the scientific labors of Baeyer, an excerpt from "Vierteljahrsschrift der Astronomische Gesellschaft," Band 2, Heft 1, to which I am indebted for many facts of interest. A list of Baeyer's writings can be found in "Literatur der praktischen und theoretischen Gradmessungs-Arbeiten," an appendix to the report of the Permanent Commission for 1881. A revised edition of this valuable publication will appear in connection with the report for 1886.

CORRESPONDENCE.

"THE SAVAGERY OF BOYHOOD."

Editor Popular Science Monthly:

SIR: Under the above title an article appeared in your October number, against the conclusions of which I beg to enter my most emphatic protest. I regard this article as the more dangerous in its practical effects (for it is likely to be much quoted), because, with what is not true to fact, there is intermingled much with which every biologist will agree. Says the writer: "My own conviction is, that healthy boys under fifteen feel very little compassion for any suffering but that of their near relatives, their close friends, and occasionally their pet animals. Cruelty seems to be a fundamental fact in the nature of children. In view of the law of our development, which carries us along the path our ancestors have trod, how can we expect our boys to be anything else but cruel?" It is my conviction that these utterances are libels on child-nature, and as such deserve to be promptly repudiated. When the doctrine of evolution is made responsible for such views as these, I do not wonder that it becomes distasteful to persons of sensibility, who may not, however, have the requisite knowledge to enable them to see through the fallacies. Doubtless there is a certain proportion of boys of whom the statements of the writer in question may be true, but they do not constitute the majority even as things are now. Incidents like those cited by the writer do show how faulty and imperfect is our treatment of the mental and moral nature of children, and not that such conduct is natural to the healthy and normally developed youth. After having been a pretty close observer of children of both sexes for many years, I have been led to adopt views totally opposed to those advanced by the writer of "The Savagery of Boyhood." The child born in civilization, when neglected or ill-taught, may certainly be somewhat of a savage; and such he would remain, but for the education forced upon him by his surroundings in later life. With the great majority of children of both sexes there is, however, the natural tendency to regard the lower creation with interest, and a sympathy sometimes even ludicrous. The secret of the development of these feelings lies in explaining to a child, when still quite young, the nature of animals great and small, in a way it can understand, so as to bring out the fact that they are *like ourselves*—very like ourselves. To illustrate imperfectly by an example: A child of five years that had always been taught thus to regard the animal creation was amusing itself by watching a cockroach confined for the time under a tumbler. Presently several children of its own age came in to play. The cockroach escaped, and one of these "savages" promptly crushed it—precisely as it had always been taught by example to do. The first child burst into a flood of tears, and declared it wanted no more of such playmates. Inasmuch as I have known this child intimately for most of its lifetime, I think I should have been able to detect physical disease (which is the kind our writer refers to), but this child is neither specially precocious nor in any way diseased so far as can be discovered—and I am not without experience in making such discriminations. No, the "savagery" is the result of our own neglect or educational bungling. I regard the views of the writer of the article in question as especially pernicious, because they will tend to encourage parents and educators to put the blame upon Nature that should be laid at their own doors—or rather, perhaps, to acquiesce in a state of things that calls loudly for correction. Until adults realize that the lower animals are *fellow-creatures* in a fuller sense than at present, the teaching children get, with regard to their relations to them, must be very ineffectual. Fortunately, there is some literature that can be put into the hands of young children that will do good in this direction. I do not think most boys could read such works as those from the pen of Dr. Charles C. Abbott (e. g., "A Naturalist's Rambles about Home"), without losing—if they ever had it—what Mr. Johnson is pleased to call their "savagery" of nature; especially if perused under the guidance of an intelligent parent who himself really had any sympathy with our "poor relations." The doctrines of "The Savagery of Boyhood" remind me of certain others almost equally unfounded in nature, though less harmful, in regard to allowing children to carry on all their social life and amusements after their own crude notions. Do those holding such views consider that it can be shown, almost to a biological demonstration, that what each one of us is to-day is the resultant of all that has gone before in our own history and that of our ancestors? How shall we have well-balanced and order-loving men if we encourage children in disorder? The mischief of later years is largely the outcome of ill-directed activities in childhood. Would that we really believed that whatsoever an individual sows, either as boy or man, that shall he also reap, holds of necessity of man's entire nature! Not to occupy too much of your space, Mr. Editor, I conclude by expressing the hope that the readers of the "Monthly" will not adopt the views expressed in "The Savagery of Boyhood," till they have some sounder basis for them than has yet been furnished.

T. Wesley Mills.

Physiological Laboratory, McGill College, Montreal, *October* 8, 1887.

TOLSTOI'S ASTRONOMY.

Editor Popular Science Monthly:

Sir: The great Russian novelist, Count Leo Tolstoi, in his powerful story, "Anna Karénina," makes a curious mistake in describing the phenomena of the heavens, which will do to put with those you have noted in regard to the moon. After describing with great beauty and fidelity to nature a spring day, he says (page 176, Crowell's edition, New York):

"It grew darker and darker. Venus, with silvery light, shone out in the west; and in the east Arcturus gleamed with his sombre, reddish fire. At intervals Levin saw the Great Bear. No more snipe appeared; but Levin resolved to wait until Venus, which was visible through the branches of his birch-tree, rose clear above the hills on the horizon, and till the Great Bear was entirely visible. The star had passed beyond the birch-trees, and the Wain of the Bear was shining out clear in the sky," etc.

Venus, when seen in the west as evening star, would, on the same evening, sink lower instead of rising higher. It is curious that Count Tolstoi, who is in general an accurate observer of Nature, and who shows, in this very passage, that he has watched the heavens on spring evenings, should make such a mistake. He has confused the apparent and real motions of Venus evidently.

Eliza A. Bowen.

September 20, 1887.

EDITOR'S TABLE.

AN ALLEGED ARGUMENT AGAINST EVOLUTION.

THE "Journal of Commerce" of this city has been occupying itself lately with the question of the origin of the human race; and, as the result of its studies and reflections, feels justified in pronouncing that "the development theory is refuted by all human experience." The main argument on which our contemporary relies to support this opinion is that there is no "organic tendency toward constant improvement and greater uprightness," that it is not natural for man to be good, and that he only attains to any moral excellence through unceasing struggle. No text-book in theology—so we are informed—is needed to tell us that the race is not attaining to moral goodness by the slow process of natural development; the conflict in every man's breast being sufficient to assure him that the ideal which he pursues is the original image of perfect righteousness that has been defaced by manifold transgressions. Such is the argument of our contemporary, stated, as nearly as possible, in its own words. We need hardly say that we are glad to find a paper like the "Journal of Commerce" presenting subjects of this character for the consideration of its readers; and we feel assured that it will be prepared to examine in a candid spirit the comments we propose to offer on the view above outlined.

In the first place, we would observe, the theory of evolution is one of a very wide compass; and, if it is applied with some degree of confidence to the history of morals, it is because, in so many other fields, it has proved itself the key to phenomena otherwise unexplainable. The language held by Professor Morse before the American Association for the Advancement of Science, and by Professors Roscoe, Newton, and others before the similar British Association, sufficiently proves in what light the doctrine of evolution is regarded by the most eminent scientific investigators of our day. The question, therefore, presents itself as to whether man's moral nature has been formed upon principles, and by a method, wholly different from those illustrated in every other domain accessible to human inquiry. Before we grapple with this question, however, it will be well to place before ourselves as clear an idea as possible of what man's moral nature is.

The moral nature of man, according to our understanding of the expression, is that part of the human consciousness which takes cognizance of, and is definitely affected by, *conduct*, as that term is employed both by Herbert Spencer and by Matthew Arnold. That there should be a sense for conduct is as natural as that there should be a sense for any other outward phenomenon; and, if so, we can readily understand that an individual may examine and criticise his own conduct just as he may examine and criticise his own personal appearance. The norm or standard in both cases—that is to say, whether conduct or physical structure is in question—is the same, namely, some assumed ideal suitable to the human race, and in a manner generalized from varying human characteristics. Nobody, so far as we are aware, aspires either to a virtue or to a beauty appropriate to any non-human race of beings. Enough for a man to be a man in the best sense; enough for a woman to fulfill the best type of womanhood. But this striving after a type, what does it imply? Our contemporary says that, so far as conduct is concerned, it implies the original creation of a perfect moral nature, which sin has marred, but of which a perpetual reminiscence lingers. Good! but how about the striving after physical beauty? Does that also imply the reminiscence of a lost perfection? Or does it merely imply a sense in the individual of that which constitutes the best expression of the species? We incline to the latter opinion, and we think a similar answer might be given to the question as to the striving after a moral ideal.

The fact should not be lost sight of that our ideas in regard both to beauty of conduct and to beauty of form are very greatly controlled by habit and tradition. The standard of physical beauty varies from country to country, so that what inspires admiration here may be regarded as far from attractive there; and the same may be said of the standard of virtue. What is deemed most worthy of imitation in one age or clime may be regarded with positive disapproval under changed conditions of time or place. The very words "moral" and "ethical" teach us a lesson under this head; since the essential meaning of both, if we revert to their etymology, is neither more nor less than "customary." The first notions of morality were therefore based wholly on custom; and only as reflection developed, and as the contact of tribe with tribe and nation with nation gave the opportunity of comparing custom with custom, did the notion of morality enlarge and purify itself. The red Indian of former days would strive to harden himself against physical suffering, and to deaden in his heart any stirrings of compassion for a fallen foe. Are we to suppose that the original typical or ideal human nature was one, the main features of which were physical endurance and remorseless cruelty? If not, the argument drawn from the sense of struggle or conflict must fall to the ground; for undoubtedly every individual Indian had to *strive* in order to bring himself up to the true heroic level, as understood in his tribe. The need for effort to attain any moral ideal, whether that of the red Indian or that of the most public-schooled inhabitant of Massachusetts or New York, seems to us to be strictly comparable and analogous to the need for educational effort of other kinds. The family, the tribe, the race, acquire knowledge, habits, and principles of one kind or another, which every new-born individual must grow up into, on pain of social failure and probably of early extinction. By the observation, the thought, the suffering of many, experience is gained, and by self-control and self-direction that experience is applied to the government of life. If the individual, with his narrower personal experience, wishes to share in the general fund of wisdom and morality acquired by the social aggregate to which he belongs, he can only do it by conscious effort. The customary morality of the community is impressed upon him, in the first place, by public opinion, and it is left to him to check his purely individual impulses in the degree necessary for realizing (perchance transcending) the social ideal. It may further be observed that the ideal toward which the individual strives is identical with the standard of conduct which he is disposed to exact from his neighbor. Thus, to each man, conscience is the echo of the demands he makes upon others in the matter of conduct. Every man wants truth and justice and kindly help when necessary from his fellow-man; why, then, should he not yield them in return? How can he fail to at least profess a conformity with the standard he sets up for others? And if he continually professes to acknowledge that standard, how can he fail to strive more or less to adjust himself to it? If this involves conflict, on the one hand, it promises escape from conflict on the other—the conflict between a man's inner and outer self, between his professions and his practice.

We are thus very naturally led to see that the sense of effort in the individual is in no way incompatible with the existence of general tendencies by which human conduct is raised to successively higher levels. We scarcely gather from our contemporary's article above referred to that he has taken any pains to familiarize himself with the arguments of the evolutionist school. If he will not shun the effort needed for this purpose, but will read with attention Herbert Spencer's "Data of Ethics," or even so brief a treatise as Mr. Fiske's "Destiny of Man," we think he will find himself confronted with indubitable evidence that there has been an evolution in morals and in thought as well as in physical structure; and that this has been carried on, in the main, independently of mere individual volition. What the individual has to do is to keep up with the procession, and take a front rank in it if he can; he does not make the procession, nor can he greatly accelerate or retard the speed of its movement.

We might, indeed, turn our contemporary's argument against him by asking how it is, if a certain moral constitution was imparted to man at the outset, that so much struggle should be involved in getting back to it. Reversion is generally, if not always, an easy process; the difficult thing is to add something to the ancestral inheritance. Evolutionists say that, if wrong-doing is easier than right-doing, it is because wrong-doing implies falling back on the more deeply implanted primitive instincts, and right-doing the exercise of more recently acquired and morally higher instincts. To be sensual merely requires a yielding to appetite; to be unjust, a compliance with some selfish motive; to be cruel, the indulgence of the instinct for destruction. Primitive man, wherever we find him, is sensual, unjust, and cruel; and the hoodlums and ruffians of our great towns show to-day the same characteristic. If, then, men have to struggle in order to be moral, in order to attain to "righteousness," it is because the higher moral attributes are of comparatively recent development, and not as yet as thoroughly worked into human nature as the primitive, self-regarding instincts. We are glad to have had this opportunity of discussing an important and interesting question; and we trust the "Journal of

Commerce" may find frequent occasion in future to introduce similar philosophical themes to the notice of its readers.

TRUTH AND ITS PURSUIT.

There is a well-known saying of Lessing's, according to which the pursuit of truth is rated as of higher value, and more to be desired, than the truth itself. Sir Henry Roscoe quoted this sentiment in his recent inaugural address to the British Association; and the London "Spectator," in a thoughtful article—all the "Spectator's" articles, we may say in passing, are thoughtful—raises the question as to whether Lessing's "paradox," as it calls it, conveys as much truth as is commonly supposed. It points out that, in scientific matters generally, the truths discovered are of value to thousands who take no part, and are incapable of taking any part, in bringing them to light; and that, even in regard to moral questions, it is impossible to conceive of the pursuit of truth having any value apart from a strong conviction of the value of the result to be arrived at. If the result is not itself of value, or at least is not believed to be of value, then there is nothing ennobling in pursuing it. If, on the other hand, the result is of value, and so far lends significance and dignity to the pursuit, how can we say that the mere pursuit, cut off from all hope of an actual realization of the truth, is of more value than the truth itself? How, indeed, can we regard it as having any elevating effect whatever?

All that can be said in reply to this reasoning, so far as we can see, is that we should not demand from Lessing's paradox more than, as a paradox, it is able to render. The function of a paradox, as we conceive it, is to draw attention to some aspect of truth which is in danger of being overlooked, and to do this by piercing below the level at which our thought ordinarily rests. Thus, in regard to truth, it is natural to think only of results, and to regard as failure all that does not lead to results. Here Lessing steps in to tell us, and truly, in our opinion, that more valuable than the discovery of any particular truth is the tendency of the mind toward truth in general. Truth, when realized, increases the resources of the human mind, or, as we may say, the intellectual capital of the human race. It is like the dollar won by honest labor, and henceforth available for the production of further capital. But, if such is the character and such the value of realized truth, what shall we say of the effort, of the concentration of mind and purpose, that led to its discovery? We can surely say that the discipline thus gained is often of far greater value, at least to the individual, than the final result of his labors. Thus, also, the dollar gained may really be of far less account than the qualities developed in the gaining of it. Of course, it may sometimes be the case, on the other hand, that comparatively slight labor and thought—mere accident even—may sometimes result in the discovery of some truth of the highest importance; just as one might, with slight or no searching, light upon a source of unlimited material wealth. From this point of view we have to consider what human life would be if all our discoveries came to us in this way without effort, and without any need for the self-control and patient industry which the serious pursuit of truth now involves. In trying to form a conception of this we seem to escape from all bounds of law, and to find ourselves in a region where the stable landmarks of human existence have disappeared. Work is man's discipline on this earth; and, without that discipline, he would be a poor, wayward, worthless creature, if, indeed, we can conceive him as existing as an intellectual being at all.

Lessing's paradox, then, presents us with an impossible situation. The choice between truth and the pursuit of truth could not conceivably be offered to any one; nor could such a thing be as an ever-fruitless pursuit of truth; nor yet such a thing as a system of truth grasped by the human mind independently of all previous attempts toward its construction. The very sense that truth is truth comes from a perception of harmony between an attained result and a set of circumstances or phenomena of which it affords a *desired* explanation. Had the explanation never been desired and sought after, no interest or value could possibly attach to it. While, however, the situation that Lessing's words suggest is an impossible one, our attention is none the less roused by it to the fact that, not by outward results alone is the value of human effort to be gauged, but also, and perhaps mainly, by the inward growth of mind and character which is its accompaniment. We learn, also, that to be loyal to the truth is of more account than to be merely successful in formulating it: in a word, that the interests of the human spirit, or, perhaps more correctly, of the intellectual and moral consciousness, are supreme, and that the great flow of significance, so to speak, is from within the human consciousness to the outward conditions, and not from without inward.

LITERARY NOTICES.

The Elements of Political Economy, with some Applications to Questions of the Day. By J. Laurence Laughlin. New York: D. Appleton & Co. 1887. Price, $1.40.

If the numerous school-books that appear in our time were all they ought to be, the education of the young, so far as books can aid it, would be amply provided for, but unfortunately such is not the case. In the mathematical and physical sciences, indeed, and in classical literature, there are many good text-books; but in the sciences that treat of mind and society the works of real merit are comparatively few. The reason of this scarcity is twofold: in the first place, these sciences are not so well developed as physics and mathematics and classical philology, and there is less agreement about the method of studying them—the mutual opposition of the philosophical and historical schools being specially conspicuous; and, secondly, the close connection of the mental and social sciences with the great disputed questions of politics and religion render the pure scientific treatment of them difficult. Hence we have at present but few satisfactory treatises on political, economical, or ethical subjects.

This work by Professor Laughlin, however, is distinctly superior to most of the current writings on economical themes, and seems to be well adapted to educational use. It makes no pretension to originality in doctrine or theory; but undertakes to give the student, in as simple a form as possible, the leading thoughts and conclusions of the great economic writers. The author remarks in his preface that "the public questions of our day in the United States are deeply affected by economic considerations, and yet the training of mind adequate for an intelligent decision upon economic problems has been very slight." Yet he thinks that "public questions and the economic principles which underlie them can, if properly presented, be understood by the average American youth whose education is restricted to the high-school or the academy." For such students, then, and with such an aim, Professor Laughlin has written, and with much success. His arrangement is good, his style clear, and his views, in the main, such as are best established. He has avoided controversy, so far as possible, evidently thinking it unsuitable to an elementary work. If we were to offer a criticism on the author's method, we should say that he had confined himself a little too strictly to the deductive or philosophical method of the English writers, with too little attention to the historical and comparative method; for, though we have no faith in the historical method as a substitute for the other, it nevertheless has its uses.

Professor Laughlin's book is divided into two parts: the first, treating of the principles of the science; the second, of their application to some of the political and industrial problems of the day. In an introductory chapter he distinguishes the subject of the science from those of ethics, politics, and other branches of science or practice with which it is liable to be confounded, and lays down the principle that "political economy deals only with questions connected with wealth and with the satisfaction of material wants." It "does not say what is right or wrong, or how a people should be governed; but it attempts to show what the rules are that control the production, exchange, and distribution of all the wealth which we see in the wonderful industrial system about us." It is refreshing, amid all the confusion that so widely prevails between economical and ethical truth, to find an economist with so clear a grasp of his subject. He distinguishes between "immaterial wealth," such as a speech or a song, and "material wealth," which has a permanent character; and defines material wealth as "some transferable thing for the enjoyment of which we are willing to undergo a sacrifice." He gives the usual account of the agents of production, and then passes to the subject of exchange. He defines value as ratio of exchange, and from another point of view as purchasing power. Cost of production he holds to consist in the sacrifices made by the different classes engaged in production; and on this subject he is careful to avoid the mistake made by the earlier writers of considering economic phenomena too much from the standpoint of the capitalist. On the subject of demand and supply, he adopts in the main the views of Cairnes, as he also does in regard to the wages of different classes of laborers. On the subject of distribution, now so hotly debated, Professor Laughlin takes conservative ground, holding that "the proportional shares of labor and capital out of the product will depend upon the relative scarcity and abundance of labor and capital," and that "the productiveness of a country's industries determines whether the general level of the wages shall be high or low." He takes conservative ground, also, in regard to labor-unions, approving them in some respects, and disapproving them in others; and he devotes a special chapter to "the industrial manager," showing the important place which he holds in the industrial system of the present day.

In treating of the applications of economic principles, the author discusses socialism, free trade, and protection, money questions, the labor problem, and other topics, indicating briefly the bearing on each of the doctrines advanced in the earlier portion of his work. On the subject of the tariff he gives the arguments on both sides, but is himself evidently a believer in free trade. In regard to bimetallism he reiterates the views that he had already more elaborately stated in a separate work. He opposes socialism, of course, and teaches that the welfare of the laboring-classes can only be secured by their own moral and intellectual advancement. He strongly deprecates state interference, and favors co-operation in all its forms.

The book is an excellent elementary presentation of a difficult subject of growing interest and importance, and as such it deserves a place in both public and private schools.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. XXXI. Popular Tribunals. Vol. I. San Francisco: The History Company. Pp. 749. Price, $5.

This volume stands apart from the other members of Mr. Bancroft's historical series. It has a character of its own, as do the events to which it relates. They have hardly a parallel in history. The volume particularly relates to those voluntary courts or self-organized associations of citizens for the administration of justice and the avenging of wrongs which, in some of their forms, have marked the society of the frontiers during the whole of the history of the settlement of our country; which were prevalent throughout California in the early days of the American settlement; and which found their most remarkable exemplification in the vigilance committees of San Francisco. Mr. Bancroft endeavors to draw a distinction between the vigilance movement in California and all other exhibitions of popular justice which are recorded. He does not find anything exactly like it in the public uprisings of which ancient and modern history furnish examples; and to his view it was very widely different from the mob law, lynch law, regulators' law, etc., with which it is too easy to associate it in classification. "In some respects," he says, "they are diametrically opposed in principle and in purpose. The vigilance committee is not a mob; it is to a mob as revolution is to rebellion, the name being somewhat according to its strength. Neither is a tumultuous rabble a vigilance committee. Indeed, prominent among its other functions is that of holding brute force and vulgar sentiment in wholesome fear." It is founded on a principle, and this is that "the people, or a majority of them, possess the right, nay, that it is their bounden duty, to hold perpetual vigil in all matters relating to their government, to guard their laws with circumspection, and sleeplessly to watch their servants chosen to execute them. Yet more is implied. Possessing this right, and acknowledging the obligation, it is their further right and duty, whenever they see the laws which they have made trampled upon, distorted, or prostituted, to rise in their sovereign privilege, remove such unfaithful servants, lawfully if possible, arbitrarily if necessary. . . . When law fails—that is to say, when a power rises in society antagonistic at once to statutory law and to the will of the people—the people must crush the enemy of their law or be crushed by it. A true vigilance committee is the expression of power on the part of the people in the absence or impotence of law." . . . As defined in this book, "the principle of vigilance takes its place above formulated law, which is its creature, and is directly antagonistic to the mobile spirit which springs from passion and contemptuously regards all law save the law of revenge." As may be inferred from these quotations, Mr. Bancroft is rather warmly in favor of California "vigilance," and appreciates highly the fruits which San Francisco has reaped from the exercise of it. He has obtained the materials for the historical record of its operations from first hands. Besides printed books, manuscripts, and the several journals of the period advocating both sides of the question, he secured all the archives of the San Francisco Committee of Vigilance of 1851, and had free access to the voluminous records and documents of the great committee of 1856. Further than these, he personally questioned the actors in the scenes who were living, and, after a little difficulty in overcoming the reserves of some of them, obtained such information as they could give him. The questioning, he thinks, was done at a most opportune time. "Ten years earlier, the actors in these abnormal events would, on no account, have divulged their secrets; ten years later, many of them will have passed away, and the opportunity be forever lost for obtaining information which they alone can give." The story is of the most fascinating character; and did not require, to intensify its interest—which is marred rather than heightened by it—the sensational style, hardly befitting a sober history, which the narrator has employed in some parts of his account. About four hundred pages of the volume are taken up with the history of the San Francisco Vigilance Committee of 1851; the rest is devoted to the operations of the "country committees of vigilance," and of popular tribunals in other States and Territories of the West, British Columbia, and Alaska.

English History from Contemporary Writers. Edward III and his Wars. Arranged and edited by W. J. Ashley. The Misrule of Henry III. Selected and arranged by Rev. W. H. Hutton. New York: G. P. Putnam's Sons, 1887.

The study of history in the usual way, though it gives a comprehensive view of the subject in the language of our own time, has nevertheless its drawbacks. However scientific the historian's work may be, and however entertaining his story, it does not give us that vivid and characteristic view of an age that we get from the contemporary writers. A consciousness of this fact has led to the preparation of this series of volumes on the history of England. They consist entirely of extracts from writers who lived in the times treated, with only such brief notes and introductions as are necessary to explain their significance and connection. The authors from which the compilation is made are of course the mediæval chroniclers, such as Froissart, Matthew of Paris, and others, while laws and other public documents are cited as occasion requires. The volumes now before us treat of the thirteenth and fourteenth centuries, and others are projected covering the whole period of mediæval and Renaissance history. The series is under the editorship of Mr. F. York Powell, the different volumes being prepared by various writers.

The volume on Edward III is necessarily very much occupied with the wars with France and Scotland, yet the social and religious affairs of the country are not neglected, and in the "Misrule of Henry III" these subjects are the principal ones. This latter volume exhibits in a striking manner the tyranny and extortions of the Papacy during the thirteenth century, while the Statute of Provisos, the Statute of Præmunire, and other measures of Edward III's reign, illustrate the means taken to counteract the evil. The fearful epidemic of the black-death and its effects claim attention, and are briefly but vividly related. One of the most striking effects of this plague was a great rise in wages, owing to the reduction in the number of laborers, and the chroniclers relate the attempts that were made by law to keep wages down. Thus, we read that "the king sent proclamation into all the counties that reapers and other laborers should not take more than they had been accustomed to take, under the penalty appointed by statute. But the laborers were so lifted up and obstinate that they would not listen to the king's command, but if any one wished to have them he had to give them what they wanted, and either lose his fruit and crops, or satisfy the lofty and covetous wishes of the workmen." These passages are curious reading now, as are also those denouncing the taking of interest; but they show in clear light the supremacy of natural law.

Such works as these can not supply the place of the ordinary historical treatises, since they do not furnish a complete and connected view of the periods to which they relate. But they are very interesting and valuable, as giving what may be called an interior view of the times and subjects of which they treat; and students of history will look with interest for the remaining volumes of this series.

Principles of Art. By John C. Van Dyke. New York: Fords, Howard & Hulbert, 1887. $1.50.

This book is an elementary treatise on the history and theory of art. It makes no pretension to originality or to scientific profundity, but is intended for the mass of people that are interested in the subject. The discussion chiefly relates to the arts of form and color—architecture, painting, and sculpture; the other fine arts, such as music and poetry, being introduced only for purposes of illustration. The book is divided into two parts, the first of which deals with the history of art, the second with its philosophy. The author's views of the development of art are substantially those generally held by writers of the historical school. He regards the art of a nation as the product of its civilization, and thinks that "nothing can record so truly the nature of a people or a country's civilization as its art" (page 13). He holds that "art is what its age and its environment make it" (page 173). "The artist lives in his own time, and seldom ahead of or behind it. If he is striving toward the unattainable of the future, there is some impulse of his age that urges him on. If he goes back to imitate an art of the past, again some tendency of his time promotes it. Whichever way he turns, and whatever he may do, the circumstances of his surroundings rule him unconsciously" (page 13). These extracts show the author's views of artistic development; and the historical part of his work is an attempt to apply these principles to the facts of art-history. Several pages are devoted to the theory of art, but we have no space to discuss or even to explain the author's views. As regards the art of the present day, he thinks its leading characteristic is the expression of individual tastes, a view which he illustrates by numerous examples.

The Essentials of Perspective, with Illustrations by the Author. By L. W. Miller. New York: Charles Scribner's Sons. Pp. 107. Price, $1.50.

The author calls this little book "The Essentials of Perspective," because it seems to him that it contains as much information about the science of which it treats as the artist or the draughtsman ordinarily has occasion to make use of. He has aimed to produce a work exhaustive enough to present the subject adequately, and yet be as free as possible from the technical difficulties which the unscientific mind will encounter in the profounder treatises. Some unessential things are left out, in the effort to make clear the really important truth.

The illustrations are given with the aim to connect the study with the work of the artist, rather than for use as diagrams, by which to demonstrate abstractions; and they are of precisely the same character as those which the author has used for many years in teaching perspective from the blackboard. The successive chapters of the book treat of "First Principles," "The Horizon," "Measurement by Means of Parallels," "Of Diagonals" and "Of Triangles," "The Perspective of Curves," "Methods," "Shadows," "Reflections," and "Cylindrical, Curvilinear, or Panoramic Perspective."

INSTITUTES OF GENERAL HISTORY. By E. BENJAMIN ANDREWS. Boston: Silver, Rogers & Co. 1887. $2.

THIS is a rather peculiar book. It is by no means an elementary work; on the contrary, a student just beginning the study of history, would not be able to understand it, so much is taken in it for granted. But by one who already has a knowledge of the outlines of history it will be found both interesting and instructive. It is rather a series of historical essays than a regular history, and, while making no pretensions to originality, it presents in a brief form the conclusions of the leading writers on most of the main events of the past and the contributions of the various nations to the civilization of the world. English and American history are neglected on the ground that these subjects are taught in our schools by themselves. The book is broken up into short paragraphs, each followed by a mass of notes treating matters of a more specific character than those mentioned in the text.

Professor Andrews opens his work with a brief discussion of the nature and method of history, and considers the question whether history is a science. To this he gives an affirmative answer, quoting Mill's remark that "any facts are fitted in themselves to be a subject of science which follow one another according to constant laws, although those laws may not have been discovered nor even be discoverable by our existing resources." He regards historical science, however, as in an inchoate condition, and its laws as but very partially known; and he defines it as "the science of humanity viewed upon its spiritual side, and in course of evolution." Having thus stated his conception of history and the method of studying it, Professor Andrews proceeds to consider first the character of the civilization of the old Eastern nations, and then that of Greece and Rome. The classical period receives but scant treatment, apparently because it is usually taught in the schools as a separate study. Then, having sketched the character of the Roman Empire and Church, he takes up the history of modern Continental Europe, to which the greater part of the volume is devoted. This portion of the work is fuller of detail than the earlier parts, and gives a good though very condensed outline of feudalism, the Renaissance and the Reformation, the Thirty Years' War, the French Revolution, and the rise of the new German Empire. Each chapter is preceded by a bibliography of the subject of which it treats, so that the real student of history will know where to go for fuller information. The utility of such a book for educational purposes must necessarily be determined by experience; but to general readers it will be of value both for reading and for reference.

INDUSTRIAL EDUCATION. A GUIDE TO MANUAL TRAINING. By SAMUEL G. LOVE. New York: E. L. Kellogg & Co. 1887. $1.75.

THE subject treated in this volume is one of great and increasing importance. The keen competition of industrial life, and the greater skill now demanded of manual laborers, as compared with those of former times, make it necessary for all who can to learn some trade or profession; while at the same time the want of any regular system of industrial training, and the unwillingness of the labor unions to permit the taking of apprentices, render it often difficult for a young man to learn the trade to which he inclines. Under these circumstances it has been proposed to establish schools of industry for the express purpose of teaching trades, and also to introduce some system of manual training into the public schools. Special industrial schools have been established in some cases, and have proved successful; but how far industrial work can be advantageously taught in the public schools is yet an unsolved problem.

Any book, therefore, giving an account of experiments in this direction will be welcomed by all persons interested in the subject; and such a book we have now before us. The author, who has been for some years superintendent of public schools in Jamestown, New York, in it gives an account of his introduction of manual training there, together with a detailed exposition of the system of training itself. Mr. Love is, of course, an enthusiastic advocate of industrial training, and a firm believer in its great usefulness. He holds that "it ranks in importance with the study of numbers or language, in the benefits it confers on its recipients." He notes the fact that some children dislike books, while they are fond of activity; and such children, he says, are made more interested in their school-work by the introduction of manual exercises. The system was introduced into the Jamestown schools on a small scale in 1874, and has been largely extended since, with the approval of the school authorities and of the people of the town.

The greater part of Mr. Love's volume is devoted to an exposition of the exercises that are practiced in the Jamestown schools, the subject being illustrated by a great number of diagrams. In the lower grades the exercises are the same for both boys and girls, and are of a very simple character, such as building with blocks, slat-plaiting, paper-folding, mat-weaving, etc. In the grammar and high schools they consist of carpenter-work for the boys, sewing and cooking for the girls, and printing for both sexes. And here we see one of the difficulties that the system has to contend with—that of introducing a sufficiently diversified industry. Every girl should know something of cooking and sewing, though these things ought to be taught her at home; but very few boys can be either carpenters or printers, and, though a little knowledge of carpenter-work may be useful in some other industries, this can hardly be said of printing. More boys will become farmers than anything else, and it is hard to see how farming or any branch of it can be taught in the public schools. We make these remarks not by way of criticism, but to point out one of the difficulties attending the introduction of manual training. Meanwhile, a work like this that shows experimentally how to overcome any of those difficulties will be welcomed by all who are interested in the subject.

A History of the New York Academy of Sciences (formerly the Lyceum of Natural History). By Herman Le Roy Fairchild, Recording Secretary. New York: Published by the author. 1887.

This book owes its origin to a vote of the Academy, passed in June, 1886, authorizing and requesting the secretary to prepare such a manual. It was intended at first to make a short paper that might be included in a volume of the Academy's "Transactions"; but the author found an unexpected amount of material, and so expanded his essay to a volume of two hundred pages. The work has been approved by the Council of the Academy, and is now published in a limited edition of five hundred copies. It gives an interesting account of the origin of the society, which occurred in February, 1817, though the Lyceum, as it was then called, was not chartered until the next year. A list of the original members is given, and also a list of the present members. The progress of the society is duly recorded, separate chapters being given to the subjects of the library, collections, and publications, and biographies are given of several of the leading members. The author remarks that "the resident membership of the society has never been large," a fact which he attributes to the absorption of the people of the city in commercial affairs, and their consequent inattention to pure science. It is gratifying to learn, however, that the number of members at the present time is larger than ever before, and there is reason to hope that the American people will ere long give more earnest attention to science. The book is well printed, and will be welcome to all members and friends of the Academy.

Bodyke: A Chapter in the History of Irish Landlordism. By Henry Norman. New York: G. P. Putnam's Sons. 1887.

This work is an account of the eviction of several families of Irish tenants at Bodyke for non-payment of rent. The author was an eye and ear witness of much that he records, and seems to have taken considerable pains in studying up the facts. The greater part of the book consists of dispatches sent to the "Pall Mall Gazette," and published in that and several other papers; but some of the chapters are now published for the first time.

THE EFFECTS OF BEER UPON THOSE WHO MAKE AND DRINK IT; Real and Imaginary Effects of Intemperance; The System of High Licenses; Liquor Laws of the United States; Colonial Liquor Laws; Thoughts on International Temperance Meeting at Antwerp, 1885; Solution of the Temperance Problem proposed by the Government of Switzerland; and Alleged Adulterations of Malt Liquors. By G. THOMANN. TWENTY-SEVENTH BREWERS' CONVENTION, HELD AT BALTIMORE, 1887. New York: United States Brewers' Association, 1884–'87.

NEW YORK STATE BOARD OF HEALTH REPORTS ON EXAMINATIONS OF BEERS. New York: The State, 1886.

THE pamphlets named at the head of this article are issued by the Brewers' Association, with the declared purpose of promoting temperance by substituting the use of beer for spirituous liquors. The Association has a literary bureau, which is engaged in disseminating the doctrine, held by many other people besides brewers, that the best way to promote temperance is to extend the use of the weaker liquers and restrict that of the stronger ones. Accordingly, it advocates high taxes on distilled liquors, and the removal of the taxes now imposed upon ale and beer. The various pamphlets before us are mostly prepared by Mr. Thomann, the manager of the bureau, or under his supervision, and treat of various aspects of the subject under discussion. Some of them are designed to combat certain assertions and arguments of the prohibitionists; others are devoted to examining the effects of excise and other laws that have been enacted by different governments in relation to liquors. Those on the liquor laws of this country, contain a large amount of information tending to show that restrictions on the sale of malt liquors lead to a larger consumption of the products of the still.

Perhaps the work most important to the brewers' argument is that upon the effects of beer upon those who use it freely. It opens with a quotation from a total-abstinence writer, to the effect that beer inevitably produces various diseases, disorders of the liver and the kidneys being specially insisted on. Allusion is also made to the fact that one or two life-insurance companies had come to the conclusion that insuring the lives of habitual beer-drinkers was too risky to be advisable. To these facts and assertions, Mr. Thomann replies, first, by citing the opinion of certain physicians to the opposite effect, and then goes on to give some statistics relating to the health and longevity of the workmen in the breweries of New York and its vicinity. The brewers of this and the neighboring cities have a benevolent association for assisting sick and disabled workmen, and this association has established a system of medical supervision and examination which has collected facts regarding the health of the workmen generally, and the cause of the deaths occurring among them. The men have the privilege of drinking without cost all the beer they want, and consume an average of ten pints a day; yet, according to the statistics that are given, the death-rate among them is less than that of the generality of city residents as given in the United States census. In reply to the charge often made that beer is adulterated, Mr. Thomann cites the report of the New York State Board of Health to the effect that the four-hundred and seventy-six samples of malt liquors examined by them contained no deleterious ingredient whatever. These pamphlets will be sure to attract the attention of all interested in the subject of temperance, and may lead to a renewed discussion of the whole question of prohibitive and restrictive legislation.

BULLETIN OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON. Vol. ix, for 1886. Washington, 1887.

AT the annual meeting of this society for 1886, papers were presented on a variety of topics, including even a phonetic alphabet. The Charleston earthquake was the subject of a long discussion, and there were also papers on other geological topics. A communication was presented on Lieutenant Lockwood's polar expedition, showing that that explorer had penetrated to a point nearer the north pole than any one else. There was also a paper, which led to some discussion, on the origin and antiquity of certain social customs, such as bowing and kissing. The communication most interesting to the general reader was the address of the president, Dr. John S. Billings, on "Scientific Men and their Duties." Dr. Billings defines a scientific man as one "who uses scientific method in the work to which he specially devotes himself; who possesses scientific knowledge, not in all departments but in certain special fields." A man of science, on the other hand, is "a man who belongs to science peculiarly and especially, whose chief object in life is scientific investigation, whose thoughts and hopes and desires are mainly concentrated upon his research for new knowledge." He does not, however, agree with the view often expressed that the pursuit of knowledge for the mere pleasure of knowing is the true business of the man of science. On the contrary, he holds that the duty of men of science is to promote the welfare of mankind, and not merely to gratify personal curiosity. He discusses the question of the adaptability of government officers for scientific work, approving their employment in such work, though admitting that it has its drawbacks. In closing, he notes the fact that science has not yet furnished a satisfactory basis for morality, and makes some interesting comparisons between the science of the West and the religion and philosophy of the Orient.

Federal Taxes and State Expenses. By William H. Jones. New York: G. P. Putnam's Sons. 1887.

The author of this book is an advocate of a plan that has been advanced for distributing the proceeds of the United States tax on liquors and tobacco among the several States, the same to be devoted to paying the expenses of the State governments. The United States stand alone among the nations of the earth in having a public revenue so large that they don't know what to do with it; and manifold are the schemes that are brought forward for getting rid of it. One of the strangest of these is that which is advocated in this volume. Most people would regard it as unconstitutional; at all events, its adoption would be a great departure from the hitherto uniform practice of the Government. Mr. Jones, however, is a firm believer in it; and those who wish to know what can be said in its favor will find it in his pages.

The Game of Logic. By Lewis Carroll. London and New York: Macmillan & Co. Pp. 96. Price, $1.

With each copy of this book is given an envelope, containing a diagram on a card, with nine counters. The diagram represents in its several divisions different classes of propositions; the counters are intended to mark the particular kinds of propositions, etc., which are to be employed in the problem at the moment seeking solution. The whole is designed to afford a graphic illustration, with tangible symbols, of the logical processes of drawing conclusions from premises. The game requires the counters to be of two colors, say four of red and five of gray, and may be played by one or more players.

Elementary Treatise in Determinants. By William G. Peck. New York and Chicago: A. S. Barnes & Co. Pp. 47. Price, 75 cents.

An acquaintance by students with the elementary principles of determinants being demanded by recent advances in mathematics, this book was prepared for the use of a class about to enter upon a course of modern co-ordinate geometry. It is a work in pure mathematics, the value of which can be adequately estimated only by experts in that department of the sciences.

Sixth Annual Report of the United States Geological Survey to the Secretary of the Interior: 1884–'85. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 570.

The topographical survey of the United States was extended, during the year covered by this report, over an area of 57,568 square miles, at an average cost of about three dollars per square mile. The results of the survey are to be embodied in maps, which will be published in scales of (approximately) one, two, and four miles to the inch; and is to be engraved in sheets, of which the unit will be one square degree; so that the maps of the different scales will require, respectively, sixteen, four, and one sheets, for each square of one degree of longitude and one of latitude. The organization of the survey includes five paleontological laboratories, in which the fossils collected by the geologists in the field are described and reported upon; a chemical laboratory, laboratories of physical research and lithology; a division of mining statistics, and a division for preparing illustrations for the reports. The general geological work is organized into divisions of glacial; volcanic; Appalachian archæan; Lake Superior archæan; the areal, structural, and historic geology of the Appalachian region; the Yellowstone Park; and two mining divisions. The appointments to positions in the survey are made, on recommendation in case of persons of recognized scientific reputation in their several fields, and through civil-service examination for younger men. The work of each division of the survey is represented in the special report of its chief. A conception of the general character of the work, as a whole, may be gained from a view of the "accompanying papers." They are "Mount Taylor and the Zuñi Plateau," by Captain Dutton; "The Driftless Area of the Upper Mississippi Valley," by T. C. Chamberlin and Rollin D. Salisbury; "The Quantitative Determination of Silver by Means of the Microscope," by J. S. Curtis; "Sea-coast Swamps of the Eastern United States," by Professor N. S. Shaler; and "Synopsis of the Flora of the Laramie Group," by Lester F. Ward.

Forty-fifth Annual Report of the Board of Education of the City of New York. New York: Hall of the Board of Education. Pp. 271.

The whole number of children taught during the year, including the "corporate schools," was 304,758, and the average attendance, 153,643; while 3,998 teachers were employed. The average cost of instruction per pupil was $15.49½ in the primary departments and schools, and $29.80 in the grammar-schools. Corporeal punishment being prohibited, the severest penalty that may be inflicted is suspension or expulsion; and the efficiency of the system is claimed to be apparent in the constant diminution of the number of suspensions. While the subject of industrial education in the public schools has been under consideration, no conclusion has been reached upon it; but the city superintendent has been directed to make investigations upon it for advising the board as to the best action to be taken in the matter. The thoroughness of the drill and discipline of the common schools is exemplified by the fact that it requires but a single day to add, without confusion or disorder, six hundred new students to the classes of the college. The question of the introduction of manual training into the schools has engaged attention, but it has been deemed wise to proceed slowly. A committee has reported favorably, and advised that it be introduced at an early date. Manual instruction is, however, already in operation in the City College, where three workshops have been fitted up, with tools for various kinds of work in wood and metal; practical laboratories in chemistry and physics have been furnished; facilities are given for investigations in natural history; and advanced work is done in industrial drawing.

Johns Hopkins University Studies in Historical and Political Science. Fifth Series. Nos. I and II. The City Government of Philadelphia. By E. P. Allinson and Boies Penrose. 50 cents. No. III. The City Government of Boston. By J. M. Bugbee. 25 cents. Baltimore: The University. 1887.

The best mode of governing cities has been for many years one of the leading questions in American politics; and the problem is by no means solved even yet, notwithstanding the many experiments that have been made. Under such circumstances anything that promises to shed light on the subject, from whatever point of view, is welcome. Among recent historical works on the subject, the publications of the Johns Hopkins University hold a prominent place, the fifth series of studies in historical and political science published by that institution being mainly devoted to the history of American cities. The opening numbers of the series, treating of the history of Philadelphia and Boston, named above, and give in a brief form the leading events in the municipal lives of those two cities with clearness and with an eye to practical reform. It is curious to note the great difference between these two municipalities in their origin—Philadelphia having been governed by a close corporation of between twenty and thirty members, while Boston was a pure democracy, which ultimately had over seven thousand voters—and then to trace the steps by which both were converted into cities of the modern type with essentially similar organizations. Various reform measures are described and advocated in both the pamphlets before us; but the perusal of them has only confirmed us in the view we have long held that the evils of city government are due not to defective organization, but to defects in the character of the people, for which the true remedies are educational and moral.

Our thanks are due to Mr. C. C. Vermeule, Topographer of the Geological Survey of New Jersey, for calling our attention to some errors in the summary of the work of the survey which we gave in our October number, and also for furnishing us some facts additional to what are given in the report of the State Geologist. He says: "The notice of the Geological Survey of New Jersey and of the report of the State Geologist for 1886, in the October number, contains several errors which are so important as to call for correction. The topographical survey has been in progress ten years, having been begun in 1877; and will be completed during the present year. The extension of the geodetic survey from the primary chain of triangles, which was thrown across the State about 1840, was begun by Professor E. A. Bowser, Assistant United States Coast and Geodetic Survey, in 1875; and the report in question states that this survey, not the topographical survey, will require two years more for completion. This geodetic work was still further extended by the topographical survey so as to average one station to each twenty-five square miles, the stations being at a distance of five miles apart, and not twenty-five miles, as the notice states.

"The impression is also given that the total area covered by the topographical survey at the date of the report was eighteen hundred and ninety-seven square miles, whereas the report states that this area was covered during the year 1886, and that the only work remaining to be done is the revision of five hundred and seventy square miles. At the date of this communication this work has all been done, and maps of the whole area of the State, on the scale of one inch to a mile, have been published."

A text-book of Volapük, or an easy method of acquiring the new "Universal" language, prepared by Klas August Linderfelt, Librarian of the Milwaukee Public Library, is in press, and will be published immediately by C. N. Caspar and H. H. Zahn & Co., Milwaukee. It has been prepared for the English-speaking public, on the basis of Alfred Kirchhoff's "Hilfsbuch," with a key and dictionaries. It will contain about 120 pages, and will be sold at fifty and seventy-five cents a copy.

A "Hand-book of Volapük" is also announced, by Charles E. Sprague, of 1271 Broadway, New York. It will contain expositions of the grammatical structure of Volapük; progressive exercises; cautions and hints; grammatical analyses; a vocabulary; and a key to the exercises. It can be used for home study, and presupposes only a knowledge of English grammar. Price, $1.

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POPULAR MISCELLANY.

The Proposed Monument to Audubon.—At the recent meeting in New York of the American Association for the Advancement of Science, the fact that the remains of the great naturalist Audubon lie in an obscure and little-visited portion of Trinity Cemetery, New York city, and that his tomb is unmarked by any distinguishing monument, was brought to the attention of the members. The demands upon the time of all in attendance at that meeting were so great, that no action was taken by the Association, although the most lively interest was expressed by individual members, and the propriety of marking the resting-place of the founder of American ornithology by a suitable monument was appreciated. The Audubon plot in Trinity Cemetery will probably be disturbed by the continuation westward of One Hundred and Fifty-third Street. The trustees of the cemetery have, with commendable liberality, assigned the Audubon family a new plot, close to One Hundred and Fifty-fifth Street, in full sight of Audubon Park, and near the end of Audubon Avenue, when this shall be continued from the north, and are in hearty co-operation with the monument enterprise. At the first autumn meeting of the New York Academy of Sciences, a committee was appointed to solicit funds and make all arrangements for a monument. It consists of Professor Thomas Egleston, of the School of Mines, chairman; Professor Daniel S. Martin, of Rutgers Female College, and Dr. N. L. Britton, of Columbia College. This committee has organized, with Dr. Britton as secretary and treasurer, and is now ready to receive subscriptions, which will be properly acknowledged. Checks should be made payable to N. L. Britton, treasurer, and post-office orders should be drawn on Station H, New York city. The committee estimates that from six to ten thousand dollars will be required to erect and engrave a shaft worthy the memory of America's first naturalist, and, while confident that this amount will be forthcoming, desires to have interest taken in the project by scientists in all departments throughout the country.

The Hills and Valleys of Cincinnati.—Professor Joseph F. James, in a study of the topography of Cincinnati, describes the valley, with its two ancient parallel river-terraces, in which the business part of the city is built, as girt with a line of hills, rising from three hundred and ninety-six feet above low-water in the Ohio River, or eight hundred and twenty-eight feet above the sea, the height of Mount Adams, to four hundred and sixty or eight hundred and ninety-one feet, the height of Mount Auburn. The hills were originally rounded at the top, but have been so marred by the destructive agencies of city "improvements," that they can hardly be recognized. There still remain, however, the great drainage-valleys, which have for ages carried the water from the north, south into the Ohio River. None of them, except Mill Creek, which occupies part of the ancient channel of the Ohio, are of any great extent, and this is one fact tending to prove the former insular character of the suburban parts of Cincinnati. Four of these valleys are mentioned, besides Mill Creek. While they, with their attendant heights, have added greatly to the picturesqueness of the city, they have, at the same time, been taken advantage of in the building up of the suburbs. The heights have been utilized for dwellings, while the valleys between have proved invaluable for streets. The tracing of the divide which separates the Ohio River drainage from that of Mill Creek, is an interesting study. It pursues a general northeast and southwest direction, and can still be followed in quite a definite manner for a part of its course. In two cases instances are observed of two ravines heading up close to one another on both the south and north sides of the divide; and these lend illustration to a remark that has been made by Captain Dutton, that in mountainous countries the ravines form a series of amphitheatres close to a narrow divide which remains sharp in all stages of erosion. The Rev. G. F. Wright, of Oberlin College, has found that the southern foot of the continental glacier crossed the Ohio near Point Pleasant, about twenty-five miles above the city, and recrossed it at Aurora, Indiana, blocking the course of the stream for about fifty miles. Professor I. C. White has estimated the height of this dam at six hundred and forty-five feet above low-water in the river. From the absence of any traces of glacial drift upon the hills, the author doubts if it could have been so high. Besides enlarging upon the beauty of the situation of Cincinnati, which no man can question, Professor James claims for it that, situated on part of the oldest dry land (Cambrian) in the Western world, its site "can boast of an antiquity which puts to shame many more renowned cities," its rocks being "hoary with the age of countless centuries," while the soil of New Orleans is "yet saturated with its baptismal shower"; they were gray with moss when the Devonian site of Louisville was deep under the ocean; when the sub-carboniferous of St. Louis was as yet scarcely even in process of formation; and they vastly antedate the Rocky Mountains and the Mississippi.

A Central Astronomical Agency.—In a paper on "The Extension of Astronomical Research," Professor Edward C. Pickering, of Harvard Observatory, calls attention to the fact, that while the net results of astronomical research have been of enormous pecuniary value, in certain cases large sums of money have been expended with little or no useful return. Striking instances may be mentioned of observatories without proper instruments, large telescopes idle for want of observers, and able astronomers unprovided with means of doing useful work.

The object of his paper is to suggest a way in which this waste of resources may be in part remedied, and in which money may be most advantageously employed for the extension of astronomical knowledge. This way is through the establishment of a central agency to which funds might be sent, to be expended on observatory or other work, so as to attain the best results, independently of all local and personal conditions. No institution appears to be better adapted for such service than Harvard College. It is financially strong; the management of the funds intrusted to it has been excellent; and its officers know perfectly well what are the requirements of scientific work.

The Boomerang.—Several German observers have been studying the boomerang for the discovery of the secret of its curious course of flight. Dr. H. Landois, of Münster, from intercourse with a group of native Australians who were exhibited there, has found that there are larger and smaller boomerangs. The larger ones are slender crescents, about sixty centimetres long, five and a half centimetres wide, and one centimetre thick; plane on the lower side, convex on the upper side, pointed at either end, and sharpened toward the edges. The lower end is cross-grooved, to aid in holding it. The careful manner in which the savages manipulated the weapon, trying its shape, testing its qualities, and scraping it down, is significant of the importance they attach to its having exactly the right curvature. The wood of which the instrument is made is an extraordinarily heavy Australian iron-wood; and the only tools used in making it are sharp stones and pieces of glass. The smaller boomerangs are bent at an angle of 45°, but are in other respects conformed to the larger ones. An exhibition of boomerang-throwing revealed a degree of strength in the natives which was in astonishing contrast with the thinness of their forms. They took the weapon in their right hand, with the flat side downward and the concave side forward, and with a run and a shout, threw it by a short jerk about one hundred yards up into the air. It flew away in a straight line, then turned to the left, and returned in a curved line back to the thrower, whirling around constantly and whizzing unpleasantly. The curve which the weapon describes in its return is not a screw-line or a spiral, but is more like a figure 8. The savages seemed able to control their instrument, even when wind interfered to complicate its course. Once the projectile went astray, and, coming in contact with a gentleman's hat, cut it off as cleanly as a razor would have done. Herr Hermann Froebel, of Weimar, who seems to be a manufacturer of toy-boomerangs, as he speaks of having made eleven thousand specimens of the article, believes he has discovered the mystery of its shape. It is not a crescent or even curvature, but must have a kind of nick or sharper curvature in the middle, with the two arms of unequal length, in the proportion of about four to five. The arms should not be of the same thickness, but the longer one should be pared down so as exactly to balance the shorter one. The correctness of these principles may be verified by adding a very little to the weight of either arm, or by slightly shortening the longer one. The instrument will then no longer answer its peculiar purpose any better than if it were only a common stick. The peculiarity of the motion of the boomerang is due to the difference in the length of the arms, by the operation of which a divergence from the circular is imparted to its curve of rotation. The remarkable feature of the whole matter is that such savages as the Australians should have been able to discover the peculiar properties of this form and apply them. The fact shows what extraordinary powers of observation the people of nature possess. The attempts to give a philosophical explanation of the trajectory of the boomerang variously compare it with the caroming of a billiard-ball, the sailing of a piece of paper or card-board in the air, and the flight of birds.

What is Graphite?—Graphite is not lead, as its names plumbago and "black-lead" would seem to indicate, nor is it a carburet of iron, as some works of scientific pretension still call it. Except that some impure specimens contain about as much iron as ordinary clay, it is the purest form of carbon, the diamond not excepted. Professor W. Mattieu Williams believes that it is nothing else than extremely finely divided charcoal or soot; and reasons upon the subject as follows: The hand-rails on the staircases of the Metropolitan Railway stations, after some use, become coated with a delicate film of graphite or "black-leaded." The same is seen, but more faintly, on suburban hand-rails, but not at all in rural stations. "Whence comes this graphite film? Why is it developed as we approach the center of London, reaching its maximum in the most densely populated and sootiest regions of the metropolis? My answer to these questions is, that it consists of a selection of the very finest particles of London soot. The hands of passengers in rubbing along these rails conduct a debtor and creditor transaction. There is soot-carbon on the hands and soot-carbon on the rails, as on everything, animate or inanimate, that is exposed to a London atmosphere. Some of the soot-particles on the rails are brushed off by the hands, some rubbed down and smeared on the wood; some are abstracted by the hands, and some are contributed by the hands as additions to the smearing. It is obvious that in such proceedings the coarser particles are those that will be brushed off or carried away, while only the very finest, the impalpably minute particles, will adhere as a black, varnish-like, unctuous film to the hard wood." So, when the coarsest lamp-black or ordinary soot, the finest vegetable-black, and powdered plumbago, are rubbed upon paper, the appearance of the fine black will be found to be intermediate between that of the other two substances.

What the Edible Birds' Nests are made of.—Naturalists have not been able to decide of what material the edible birds' nests are composed. Some have regarded them as made of pure animal secretions; others believe that algæ enter largely into their composition. Mr. E. L. Layard has suggested that the nests of the first quality, or those which are made early in the season, are made of secretion, but that later on, if the first nests are destroyed, the birds can not replace them by this secretion alone, and have to use extraneous substances to help in the construction. Mr. J. R. Green, of the Physiological Laboratory, Cambridge, has examined specimens of the nests of various qualities, and finds them all to become alike gelatinous in texture on soaking, and made up of laminæ affixed by their faces to one another. Some nests of inferior quality showed the presence of algæ, but neither in their mode of disposition nor in the quantity did they confirm Mr. Layard's view. The scanty amount and rregular position of the algæ would be better accounted for on the theory of their being accidental constituents. The nest-substance gave no micro-chemical reactions that could connect it at all with cellulose, so that it could not be formed by the partial digestion of the algæ and regurgitation of the resulting matter. On the other hand, it did give very striking evidence of its close relationship with the substance mucine described by various authors, and well known as a product of the animal body.

Cameos.—Cameos are made from pieces of sea-shell, of which, as every one must have noticed, while the outside is often rough and unseemly, the interior is perfectly polished, and sometimes of a brilliant color. The shells, which are usually of a species of *Cassis* and *Strombus*, natives of the West Indies, are chosen on account of the thickness and hardness of the layers, of the contrast of color between them, and of the presence of knobs on the exterior surface which render it possible to work in relief. When a cameo is begun, a piece of the shell, rather larger than the ornament is intended to be, is cut out and affixed to a holder by a kind of coarse sealing-wax. The inner surface of the shell is of course the lowest, and on the gray outside the master draws a rough outline of the design, and places the work in the hands of an apprentice, who, by means of a file, reduces the knob to the requisite height, removes all the gray matter that lies outside of the boundary-lines, and dresses the whole of the irregular surface. In this condition a cameo looks like an irregular piece of chalk rising out of a small plate of colored glass. It is now returned to the master, who again draws the design in pencil upon it; and from him it passes to another apprentice or workman, who brings out the design with a burin. In late years it has become the fashion to have cameo-portraits taken, but the likenesses, to which the artist usually manages to give a classical turn, are said to be "often striking, always clever, and generally abominable." The great fault of most modern cameo-cutters is an excessive fondness for detail.

Ground-Water and Health.—Mr. Baldwin Latham, C. E., declares, as the conclusion derived from eleven years of investigation, that there is generally a parallelism between the conditions of health and the volume of ground-water. The years in which there has been a large quantity of ground-water present have invariably been the healthiest years, while those in which there has been a small quantity have invariably been the most unhealthy periods. As a rule, the lowness of the ground-water indicates the future health, and not the state of health at the particular time of lowness; that is, the unhealthy period, as a rule, follows the period of low water, the degree of lowness indicating the intensity of future disease. In some instances an unhealthy period runs concurrently with the period of low water, but in all these cases there is clear evidence that percolation has begun before the unhealthy period comes on. These results, which are confirmed by observations made at Paris, differ from those obtained by Professor Pettenkofer, at Munich, in that he there found typhoid fever and low water concurrent; in all other respects they agree with his. There is also clear evidence, derived from experience in England, that the lowering of the subsoil water by artificial means produces a tendency to the development and dissemination of typhoid fever. It is clear, however, to the author's mind, that ground-water itself has no influence, either for good or evil, upon health, but that the lowness or highness of the water in the ground is the index of conditions which greatly influence the health of all communities. We have periods of abundance of water, and periods of low water, with both healthy and unhealthy conditions. Ground-water has been shown by Professor Pettenkofer to be chemically more impure in periods of high water when the conditions were favorable to health than when there is a low state of the ground-water and a condition unfavorable to health. The records also show that we have periods when rain has started into existence malignant diseases; while, on the other hand, we have similar heavy rainfalls accompanied by a high state of public health. The records clearly point out that it is not one circumstance alone which produces disease, but that there are at least three factors concerned in the matter, especially in the case of typhoid fever, viz.: the elements which produce disease, such as a polluted state of the ground; the conditions which are necessary for the development of disease, such as a period of dryness of the ground in those regions which water usually occupies, combined with a comparatively high degree of temperature; and conditions which will lead to the spread of the disease, such as the probable influence of a storm or rain in driving impurities out of the ground into our water-supplies, or through the instrumentality of ground-air passing into our habitations, and its reception by a population which is in a condition to receive such germs of disease. If any of these conditions is absent, diseases like typhoid do not occur. It has been pointed out by Professor Pettenkofer that in those districts in which the rivers are held up at uniform levels by rains, the conditions are favorable to health, and cholera seldom becomes epidemic. This is corroborated in great measure by the state of health at seaside resorts, which being at the natural outflow for ground-water, and owing to the uniform height of mean tide-level are placed in a condition favorable to health.

Hints in Object-Teaching.—Mrs. Sarah J. Hale, in a little book on "Infant-School Management," gives some excellent precepts for interesting children in subjects of study and making them at home in them. "In every case," she says, "the teacher must bring plenty of illustration to bear upon the lesson. In natural history the real animal, or a picture, should be exhibited, and if possible something that it furnishes us with, as, for instance, the fur of the otter, the shell of the tortoise, the quills of the porcupine. The teacher should also carefully provide herself with pictures of animals which afford strong contrasts to those with which she is dealing, as well as those which bear some general resemblance to it, that she may exercise the discriminative as well as the assimilative faculty of her pupils. In all object-lessons, various specimens of the object should be produced for examination and description; the little ones themselves must do the main part of the latter under the teacher's guidance, for these lessons are not only to enable the children to form new ideas, but they are also intended to train them in giving expression to such ideas. The teacher must make good use of the blackboard, and should practice drawing objects, so that she may illustrate with facility and precision any particular point of her lesson which can be so illustrated. All the materials, pictures, diagrams, etc., which the teacher provides from time to time should have their place in the school museum ready for future needs, and the children should be encouraged to bring contributions to such a museum, particularly such as the lessons they receive may suggest."

Artificial Production of Minerals.—According to M. Friedel, of the French Association, experimentation in the artificial production of minerals was suggested by the observation of the crystalline products accidentally formed in the metallurgic furnaces. Mitscherlich and Berthier took it up, and it has been advanced by a considerable number of experimenters. MM. Fouqué and Michel Lévy, by melting certain silicates and then exposing the vitreous mass to a lower temperature than that of fusion, have reproduced the identical minerals formed in the eruptive rocks, including the anorthite and labradorite feldspars, amphigene, pyroxene, peridote, and magnetic iron. While the granites have not been produced as such, their constituents—quartz and orthoclase and albite feldspars—have been obtained in crystals. The first essays at reproducing the zeölite groups of minerals have been made by De Schulten, by heating the silicate of soda in tubes of aluminous glass. Spinel and corundum, among precious stones, were long ago produced by Gaudin, Ebelman, H. Sainte-Claire Deville, and Caron; and MM. Frémy and Feil have more recently prepared the ruby in large crystalline masses, which possess all the properties of the natural mineral except the susceptibility for cutting. A new advance seems to have been made in producing rubies, for artificial stones of fair dimensions have been met with in the trade, which, though not as bright and transparent as the natural gems, have their hardness, density, and optical properties. The diamond alone appears to have so far resisted all attempts at reproduction.

Somnambulism. — The phenomena of somnambulism and their connection with the nerve-centers have not been satisfactorily accounted for. They probably depend primarily, says the "Lancet," upon a directing impulse of sensory origin. Some of our actions often become by practice so nearly automatic that partial sleep or stupor does not arrest their unconscious performance. In somnambulism the intellect and the controlling will are torpid, while the sensori-motor man whom they should govern is awake and active. As in dreams the intelligent sensorium is alone drowsily active, with possibly a noticeable tendency to restless movement, so there may be other states of dreaming, in which the centers of motion are stimulated to a more powerful but unconscious action. Partial counteractives to somnambulism may be found in throwing off worries, and in the proper regulation of evening meals.

British Colonial Wines. — Among the features of the Indian and Colonial Exhibition held last year in London, was the department of colonial wines, in which the Australian wines played a prominent part. The soil, climate, and other Australian conditions differing from those to which European vines are subject, have stamped these wines with an individuality, in consequence of which they can never become exact substitutes for those of Europe. The lighter qualities of the Australian wines are believed, however, to be suited for consumption in England, where the commoner wines of France might be found too cold and thin for ordinary use. The phylloxera was discovered in Australian vineyards in 1877, but was checked in a very short time by the application of summary and effective measures. The Cape of Good Hope is capable of producing immense quantities of wine per acre, amounting in some vineyards to nine times the average in France, and four times in

Australia. But the growers seem to have become careless as to the treatment of their vineyards and the quality of the wine they produce, and the exportation has fallen off. A few samples of wines were exhibited in the Canadian court. In late years much attention has been bestowed in Canada upon grape-growing and wine-making; and, in 1881, four million pounds of grapes were raised in the Dominion, of which nine tenths were grown in the province of Ontario. The wines exhibited were found sound and pleasant, and enjoy a local reputation; but they were hardly known outside of the Dominion before the Exhibition.

Qualities of Sewage-Farm Milk.—Dr. Carpenter, of Croydon, denied, during a recent discussion in the Society of Arts, that the milk produced on a farm irrigated by sewage was contaminated or less wholesome than other milk. When he became acquainted with the Croydon sewage-farm, they had difficulty in getting rid of the milk, because of the prejudice against it. But by judicious management the prejudice was worn out. The speaker knew, from personal experience, that the children who took the milk were never troubled with any of those illnesses which were said to be due to bad milk, and there were never any complaints of the milk, which was delivered once a day, becoming sour. That was a proof of its power of being assimilated by the body, and that it was of a perfectly desirable character in point of health, he knew from examination of the families who took it. They had now no difficulty in Croydon with regard to the disposal of their milk from the sewage-farm.

NOTES.

A discussion and analysis published by Professor F. G. Novy, of Ann Arbor, Michigan, in the "Pharmaceutische Rundschau," go to show that the new anæsthetic, stenocarpine, or gleditschine, which has attracted considerable attention, is nothing but a mixture of cocaine and atropine. More exactly, Professor Novy determines it to consist, essentially, of six per cent of cocaine hydrochloride; fifty per cent of atropine sulphate, and about a third of one per cent of salicylic acid, the latter being used as a preservative.

A correspondent in Whitby, Ontario, calls our attention to an omission—of considerable importance in countries liable to extreme cold—which he has observed in Dr. von Nussbaum's article on "Freezing," in the September number of the "Monthly." In the direction for rubbing with snow for the restoration of frozen parts, the author has omitted to state that the snow used should be of a temperature but little, if any, below the freezing-point. It has happened, through ignorance of this particular, that snow has been applied in cases of frost-bite of a temperature some degrees below zero—with the result, of course, of freezing the injured part still more.

In a public lecture on "Electric Lighting," delivered during the meeting of the British Association, Mr. George Forbes, after remarking that there were probably more than 300,000 arc-lamps in use in the United States, said that the Americans were also getting the start of the English in electric railways and tramways, and generally in the application of electricity to motive-power.

Dr. C. H. F. Peters, Astronomer of Hamilton College, has had conferred upon him, by the President of the French Republic, the cross of an officer of the Legion of Honor, in recognition of the services which he has rendered to science.

Mr. C. E. Monroe presented, in the American Association, the results of some experiments, in which blocks of gun-cotton, after having been stamped with certain letters, were exploded, lettered side down, on flat pieces of wrought-iron. When the letters on the blocks were stamped in relief, they appeared in relief on the iron after the explosion; but when they were sunken in the blocks, they also appeared sunken in the iron.

Mr. William L. Wakeler tells, in the "Scientific American," how he once, in Georgia, saw a snake climb a tree in a very curious manner. The snake was a "coach-whip," and, frightened by the demonstrations of his observer, made a rush for a water-oak, the long branches of which came down to within four or five feet of the ground; "then rising, until he seemed almost to stand on the end of his tail, he shot up like an arrow through the branches, getting his grip entirely by lateral pressure and not by coiling around the branches."

Professor Louis Soret, President of the Swiss Society of Natural Sciences, has remarked on the æsthetic influence of reiterated impressions as illustrated by the repetition of the same design, both in symmetrical forms, and in lined patterns, such as we see in tapestry, furniture, or buildings, whether of the same dimensions or of dimensions regularly decreasing. It is the same with regular curves; but the æsthetic influence dwells less in the sensation itself than in the conceptions which it gives of a law.

Professors Michaelson and Morley gave accounts, in the American Association, of experiments by which they sought to measure the relative velocity of the luminiferous ether and the earth. Their method was to determine the interference between two beams of light, which were reflected back and forth a number of times; one being in the direction in which the ether was supposed to be moving, and the other at right angles to that direction. No effect was found, and it was concluded that the ether must be at rest with regard to the earth. This solution, however, has to encounter difficulties, and invites further research.

General Perier and his Spanish associate, General Ibanez, have presented their report on the surveys for the geodesic and astronomical junction of Algeria and Spain across the Mediterranean, by which the measurement of the arc of the meridian is completed for 27°, or from the Shetland Islands to Laghouat in Algeria. The independent geodesic operations executed in Spain and Algeria are shown by the results to have been very precise. It is also shown that the transmission and reception of rhythmic luminous signals conveying the time from one station to another are capable of great exactness.

Dr. Hain, of Zürich, read a paper at the Swiss Society of Natural Sciences last year on the deformations which fossils undergo in mountains through the enormous pressures to which the rocks are subjected. By them Agassiz was misled into distributing the fossil fish of the older rocks into eighty distinct species; while many of these supposed species were really identical, but deformed in such various ways as to appear different.

Professor Mees, discussing, in the American Association, the velocity of tornadoes, mentioned that straws and bits of hay are often driven like darts into pine boards, and even into the dense bark of hickory-trees. He had found that to obtain similar results by shooting straws from an air-gun, velocities of from one hundred and fifty to one hundred and seventy-five miles an hour were necessary.

Dr. R. W. Shufeldt has a portrait of Audubon which the great naturalist himself painted, with the aid of a mirror. He has had the portrait photo-engraved, and has prefixed the copies to a paper which he has published giving accounts of this and other mementos of Audubon.

It is doubtful whether death in burning buildings is as horrible as is generally supposed. "The Lancet," speaking particularly of the affair of the Opéra Comique in Paris, observes that the burning seldom occurs in these cases until after death, or at least insensibility to pain, has been produced. Except under very peculiar conditions, the victim is made faint and pulseless by the carbonic acid, or the carbonic-oxide gas, before the fire reaches his body. It is the experience of persons who have been in a burning house that the heated and smoky atmosphere speedily induces a feeling of powerlessness and of indifference to what is going on around; and it is generally this stupefaction, with subsequent paralysis of feeling, that prevents judicious means being taken for escape.

M. E. Lavasseur, of Paris, has shown, by comparing the statistics of 1789 with those of the present, that chances of living long at any given age are greater now than they were before that year. The proportions are, for the survival of infants under one year, as 1,460 now, in every 2,000, to 1,186 then; for living to be forty as 1,110 to 738; and for living to be seventy-five, as 360 to 144.

OBITUARY NOTES.

Professor Kirchhoff, the discoverer of the spectrum analysis, died in Berlin in October, aged about sixty-three years. He was born in Königsberg in 1824, and came to the University of Berlin as a *privat docent* in 1837. In 1850 he was called to the chair of Physics at Heidelberg, where, with Bunsen, he prosecuted the researches which have given him a world-wide and lasting renown. He removed to Berlin in 1875.

Dr. Johannes Skalneit, President of the German Union of Analytical Chemists, and editor of the "Repertorium für Analytische Chemie," is dead. He was the author of many essays and other short works on questions of sanitary science, state medicine, and chemical analysis, and was an authority on analyses of milk and butter.

The death is reported of Dr. Johann Krejci, Professor of Botany in the University of Prague, and a member of the Bohemian Parliament.

Dr. Henry William Ravenel, botanist to the South Carolina State Department of Agriculture, died in Aiken, July 17. His speciality was fungi. He was best known by his "Fungi Caroliniani Exsiccati," of which he issued a number of pamphlets; by his "Fungi Americani Exsiccati," which he prepared in conjunction with Dr. M. C. Cooke; and by the papers which he published on the botany of his State.

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GOVERNMENTAL INTERFERENCE WITH PRODUCTION AND DISTRIBUTION.

By Hon. DAVID A. WELLS, LL. D., D. C. L., Etc.

ECONOMIC DISTURBANCE SERIES, No. VII.

ANOTHER factor of the economic disturbance of recent years (i. e., since 1873), and one which, in the opinion of the members of the British Commission "On the Depression of Trade and Industry" (1886), and also of most European writers, has been largely instrumental in occasioning universal depression of business, has been the increasing tendency among nations to favor and practically carry out the policy, that the prosperity of their respective people can be best promoted by artificially stimulating domestic industries on the one hand, and imposing restrictions on international commerce or the free interchange of products with foreign nations on the other.

After the repeal of the "Corn Laws" by Great Britain in 1846, and the subsequent gradual abandonment by that nation of its former illiberal commercial policy—followed, as were these measures, by a remarkable development of British trade and industry—the tendency of popular sentiment and the policy of governments throughout the civilized world was unquestionably in the direction of emancipating international trade from all arbitrary restrictions; and between 1854 and 1870 the leading nations negotiated numerous treaties for international commercial reciprocity for the achievement of this object, and at the same time materially reduced their duties on imports. This movement (as is now almost forgotten), first found expression in the form of positive legislation in the United States, which in 1854 negotiated a treaty which provided for a free exchange of nearly all crude materials, and mutually free fishery privileges with the British provinces of North America; and, in 1857 (by a vote of 33 to 12 in the Senate, and 124 to 71 in the House) reduced its average duty on all imports to less than 15 per cent. In fact, had not civil war intervened in 1861, the United States, in a very few years more, would have undoubtedly rivaled Great Britain in freeing its foreign trade and commerce from all restrictions, save for revenue and sanitary purposes.* In 1860, England, under the lead of Mr. Cobden, negotiated the celebrated commercial treaty with France, which, while providing for large reciprocal reductions or entire removal of many duties on exports as well as imports, also entirely abolished all absolute "prohibitions" on any branch of international commerce between the two nations; as, for example, in respect to coal, the exportation of which to France, England, under a fancied military necessity, had at one period prohibited.

Following the Anglo-French treaty, and as the result, doubtless, of its influence, twenty-seven other similar treaties were negotiated; in some one or more of which all the states of Europe, with the exception of Greece, participated; Russia even breaking through her customary reserve, and entering into more liberal commercial agreements with more than one of her neighbors. And, as many of these different treaties successively embodied new and special relaxations in respect to duties on imports—which, in virtue of the so-called "favored-nation clause" † existing in most previous treaties with other countries, became also and at once generally applicable—the area of commercial freedom and its accruing benefits extended very rapidly, and, as it were, without effort, over the greater part of Europe. So that, by the year 1870, "all the great trading nations of Europe—England, France, the states of the German Zollverein, Austria, Italy, Holland, and Belgium—had become one great international body, by all the members of which the principle of stipulating for exclusive advantages for their own commerce *seemed* to have been abandoned, and not one of whom could take off a duty without every other member at once enjoying increased commercial facilities; while within this body, the operation of the favored-nation clause was such as to make the arrival at almost unlimited freedom of exchange merely a question of time."‡

Furthermore, not only were these same governments busy during

* In 1860 a reduction of the national revenues, induced primarily by the commercial panic of 1857 and an increase of national expenditures, with threatened political troubles, led to the introduction of a bill, avowedly with the intent of restoring the tariff rates in force prior to 1857; and this bill, with amendments, increasing the rates considerably beyond that point became a law in March, 1861. But, at that date, seven of the Southern States had seceded, and had withdrawn in great part their Senators and Representatives from the Federal Congress; so that the action of Congress, at the time of the passage of this bill, affords no indication of what the legislation of the United States on the subject of the tariff would have then been had domestic tranquillity not been interrupted.

† By the "favored-nation clause" is understood that provision which has been incorporated in most treaties in modern times, by which the contracting parties agree to give to each other as good treatment as each one, then or thereafter acting severally, may give to other and the most favored nations.

‡ Address of the President (Grant Duff, M. P.) of the Department of Economy and

this period in breaking down the artificial barriers which they had previously erected against international trade, but they also sought, as never before, to overcome the natural impediments that had hitherto limited the extension of their trade relations—internal as well as external—by improving their highways, constructing and combining railways, and undertaking such stupendous engineering operations as the St. Gothard and Arlberg tunnels.

How wonderfully the trade of the states of Europe, that thus mainly co-operated for promoting the freedom of exchange, coincidently developed, with an undoubted corresponding increase in the wealth and prosperity of their people, is shown by the fact that the European trade of the six nations of Austria, Belgium, France, Holland, Italy, and Great Britain increased, during the years from 1860 to 1873, more than 100 per cent, while their aggregate population during the same period increased but 7·8 per cent. How much this remarkable increase of trade was due to the existence and influence of the commercial treaties noted, is demonstrated by the further fact that the increase of the trade of the above-named six nations during the same period with all other countries, in which the conditions of exchange had presumably not been liberalized, was at the rate of only 66 per cent. It is also interesting to note that the response made by the Chambers of Commerce and various industrial bodies throughout France to an inquiry addressed to them by the Government in 1875, not only testified to the great benefit which had accrued to French trade and industries by reason of her commercial treaties, but also expressed an almost universal wish that they might be renewed upon their expiration upon even a more liberal basis; and it is altogether probable that a similar response would have been made in most of the other countries in Europe had like inquiries at the same time been instituted.

But, after the continuance for some years of the almost universal depression of trade and industry which commenced in 1873, or after the year 1876, the tendency of the governmental policy of the states of Continental Europe, and to a great extent also popular sentiment, turned in an opposite direction, or toward commercial illiberality. And now nearly all of the liberal commercial treaties above referred to have been terminated, or notice has been given of their non-renewal; and, with the exception of Great Britain, Holland, Sweden and Norway, Denmark,* and possibly China, there is not a state in the world claiming civilization and maintaining commerce to any extent with

Trade, at the annual meeting of the British Association for the Promotion of Social Science, October, 1875.

* Denmark must be regarded as a purely agricultural country, possessing no mineral resources or mining population, and very few manufactories, "and while one half of the population live exclusively by agriculture, the industries and various branches of general trade and commerce afford occupation to less than one fourth of the whole number."—*Testimony British Commission on the Depression of Trade and Industry.*

foreign countries which has not within recent years materially advanced its import or export duties.

Russia commenced raising her duties on imports in 1877, and has continued to do so until the Russian tariff at the present time is in a great degree prohibitory, and one of the highest ever enacted in modern times by any nation, the aggregate value of its importations for 1886 being returned at only $194,450,000, a reduction of about 25 per cent in three years, or since 1883. It is also to be noted that, whenever Russia extends its dominion, laws are at once promulgated with the undisguised purpose of greatly restricting or entirely destroying any commerce which people of the newly-acquired territory may have previously possessed with other nations. Italy and Austria-Hungary raised their tariffs in 1878; Germany in 1879; France in 1881; Austria-Hungary again in 1882 and 1887; Switzerland in 1885; the Dominion of Canada in 1883 and 1887; Roumania in 1886; Belgium and Brazil in 1887; while in the United States, owing to the decline in the prices of goods subject to specific duties, the average *ad-valorem* rate of duty on dutiable merchandise has advanced from 41·61 per cent in 1884 to 45·55 per cent in 1886. In Spain the restrictions on trade have become so excessive, that the only relief open to the consumer is by alliance with the contrabandist, whose profession is becoming almost as well established as in the middle ages, when but for him, according to Blanqui, commerce would have well-nigh perished. In Holland, which has hitherto resisted all demands for increased restrictions on her foreign commerce, an association of manufacturers petitioned the Government in May, 1887, in favor of speedy legislation on the tariff, for the purpose of protection to home industries, and set forth the following as reasons for their request:

> The national industry lives in a most difficult time. It seems that the last period of the battle of life has appeared for many of its branches. Foreign competition, steeled by protection, equipped and encouraged to a decisive battle for the overpowering of a market for the world, even appears to drive aside the most natural protections of native industry. Now flour has its turn; next, cattle and meat. In other words, the aim of adjacent and more distant countries appears daily more openly. The industry of the Netherlands is menaced with a total ruin by their oppression.

And, as further illustrations of the degree to which a restrictive commercial policy is favored, and the extremes to which it is practically carried, it may be mentioned that some of the small British islands of the West Indies (Trinidad and St. Vincent, for example) maintain duties in a high degree restrictive of the interchange of their comparatively small products; while Venezuela, in 1886, when new and prospectively rich alluvial deposits of gold were discovered within her territory, at once imposed a duty of £5 ($25) on her exports of "raw gold."

To many, doubtless, these economic phenomena do not appear to admit of any ready and satisfactory explanation ; while others will unhesitatingly ascribe them to the influence and acceptation of protectionist theories and teachings, inculcated under the advantageous but specious circumstance, that the almost universal depression of trade and industry that has prevailed since 1873 commenced at a time when the general commerce of the world was absolutely more free from artificial restrictions than at any former period of its history.

The factors that have been concerned in effecting these economic changes and accompanying disturbances are not, however, simple, but somewhat numerous and complex. They, nevertheless, admit, it is believed, of clear recognition and statement. In the first place, the results of the Franco-German War—the radical changes in the character and construction of war-armaments since that period, and the continual augmentation of permanent military forces, have entailed upon all the states of Europe since 1873 continually increasing expenditures and indebtedness ; and indirect taxation, by means of duties on imports, to meet these increasing financial burdens, has been found to be most in accord with the maxim attributed to Colbert, that the perfection of taxation consists in so plucking the goose—i. e., the people—as to procure the greatest amount of feathers with the least possible amount of squawking.

Again, with the introduction and use of new, more effective, and cheaper methods or instrumentalities of production, every nation of advanced civilization has experienced, in a greater or less degree, an increase in the product of nearly all its industries save those which are essentially handicraft in character, with not only no corresponding increase, but often an actual decrease in the number of laborers to whom regular and fairly remunerative employment constitutes the only means of obtaining an independent and comfortable livelihood. Every country with accumulating productions has accordingly felt the necessity of disposing of its surplus by exporting it to the markets most freely open to it ; and, as a consequence, that has happened which might have been expected could the exact course of events have been anticipated, namely ; increased competition in every home market, engendered by increasing domestic production and the efforts of foreign producers to export (introduce) their surplus ; fiercer competition to effect sales of the excess of competitive products by the sellers of all nations in neutral markets ; and an almost irresistible tendency toward a universal depression of prices and profits, and, to a greater or less extent, a displacement of labor. It is also to be noted that as the capacity for industrial production increases, and competition to effect sales becomes fiercer, the more feverish is the anxiety to meet competition—specially on the part of foreign rivals—by producing cheaper goods ; and that this policy in the states of Continental Europe, and more particularly in Germany, is antagonizing efforts to shorten the hours of labor and restrict the factory employment of women and children; and is also tending in a marked degree to do away with the heretofore general practice of suspending labor on Sundays.*

To meet this condition or tendency of affairs, two lines of policy have commended themselves to the governments of many countries—especially in Continental Europe—as remedial and easy of execution, namely; to seek to diversify and increase the home demand for the products of domestic industry on the one hand, and to obtain new and larger markets in foreign countries for their surplus productions on the other. And the *first* of these results it has been sought to accomplish by restricting or prohibiting, through import (tariff) duties, the importation and competitive sale in their respective markets of the surplus products of other nations; and the *second*, by offering bounties on exports, or on the construction and multiplied use of vessels for employment in foreign commerce. In the pressing necessity for finding new and (if possible) exclusive markets for increasing machinery products, and for commodities whose production has been artificially stimulated, is undoubtedly also to be found the clue to the policy which within recent years has mainly prompted Germany, France, Belgium, Italy, and Spain to seek to obtain new territorial possessions in Eastern and Central Africa, Southeastern Asia, and in New Guinea and other islands of Polynesia.

The commercial policy of Russia under such circumstances must,

* The results of an extensive inquiry recently instituted by the British Government in respect to Sunday labor in Germany (and comprising with the evidence taken three large volumes) shows, that in Westphalia, Rhineland, Würtemberg, Baden, Alsace, and Brunswick Sunday work is only enforced where necessary. Different reports come, however, from Saxony, one stating that "Sunday labor has become usual in most factories and workshops solely under the stress of competition, so that the hours of divine service are now alone excluded, and these only from absolute necessity." Another report says, that Sunday labor has become "a principle with many employers," while in a number of cases the journeyman or operative seeking an engagement must bind himself to work on Sunday, and "if the workman refused to work on Sunday, reprisals on the part of the employer would be the inevitable result, and this is so, even in spite of the legal restriction of work on Sundays and festivals." "On the whole," says the "London Economist," "the evidence" (presented in the published report of the Government inquiry) "is unfavorable to the principle of Sunday labor, though it is largely carried on—in all probability more so than is admitted, for in innumerable cases it is admitted that it is hard to get at the real state of affairs. Nevertheless, there is general disinclination against putting the principle of no Sunday work into practice where the objectionable system has obtained a footing. On the part of large industrial concerns, it is said that want of continuity would often be a cause of serious loss, while without Sunday labor repairs could never be carried out, even night-work being no adequate substitute. The number of associations which recommend the absolute prohibition of Sunday labor is small in proportion to those which advocate partial prohibition. The question of Sunday labor is one of considerable interest for England, for it is unquestionable that, among the causes of Germany's ability to compete with England as a mercantile and industrial country, the fact that here more hours are worked for less money is not the least important. The prohibition of Sunday labor would, of course, mean increased cost of production; and every increase in the cost of production will render it more difficult for Germany to outrival older manufacturing countries in the markets of the world."

however, be regarded as wholly exceptional, and that of the United States as partially so. In the case of the former, her recent increased restrictions on foreign commerce, through greatly increased duties on imports, have not, apparently, been due to the acceptance of any economic theory in respect to trade, or with any reasonable expectations that an extensive prohibition of imports could permanently add to her revenues from customs; but rather because such action is an essential part of what seems to be a larger and fully accepted national policy, which aims to banish and exclude from the empire everything foreign in its nature and origin—merchandise, language, literature, immigration, and religion. While in the case of the latter the fiscal policy of the country for now more than a quarter of a century has been based upon the idea that foreign trade is injurious, and therefore importations, without which there can be no exportations, should be prevented.

Leaving Russia out of account, the nation that took the initiative in breaking in upon the system of comparatively free international exchanges that had gradually come to prevail among the commercial nations of Europe since 1860 was Austria-Hungary, which, feeling the necessity of securing larger markets for her manufactured products, increased her tariff in 1878, with the avowed expectation of obtaining, through new negotiations, greater commercial advantages or concessions, more especially from Germany, than were enjoyed under existing treaties. A similar policy also found favor at about the same time in France, and under its influence the "Anglo-French" and other commercial treaties were either allowed to lapse or were "denounced," and a new general tariff was constructed. The result was not what was probably anticipated. Increased restrictions on imports on the part of Austria, in place of inviting concessions led at once to retaliatory tariffs by Italy and Germany, and the example thus set has been followed by one European Continental state after another, each raising barrier after barrier against the competition of other nations, until all stability of duties on the numerous frontiers has practically ended, baffling the calculations alike of exporters and importers, and making the development of almost every trade and industry dependent on bounties, subsidies, and restrictions on exchanges, rather than on their own inherent strength and enterprise.

The following examples are illustrative of recent procedures in continuation of this policy: In 1885 Germany deliberately excluded Belgian linen from her markets. This act has not as yet been followed by reprisals by Belgium; but the action of Germany, in twice augmenting in recent years her duties on breadstuffs (i. e., 1880 and 1885), has been promptly imitated by Austria-Hungary, whose export of cereals was seriously affected. But, notwithstanding these increased duties on the movements of grain between Germany and Austria, the prices of cereals in both of these countries have since continually receded. In July, 1887, Russia increased her duties—which were before very high—on the imports of all foreign iron and steel, to a point that is regarded as nearly or quite prohibitory of all imports; and Germany, which has heretofore had an important market for her iron and steel wares in Russia, and has also been a large purchaser of Russian grain, has now determined to further advance her duties upon the import of all foreign cereals, her object being avowedly to shut out American as well as Russian competition. Belgium, which for many years has been the typical free-trade state of the world, and which, in 1885, by her Chamber of Deputies, refused to entertain a proposition to restrict the importation of cattle into the country, has since then, and mainly by a recognition of an inability to compete with the prices established for meats and grain by the United States and other foreign countries, felt compelled to impose high duties on the importation of all live-stock and dead meats—fresh, smoked, or salted.

In Sweden and Norway, on the other hand, where, during the past year, an effort was made under similar circumstances to restrict by increased duties the entry of foreign flour and other breadstuffs, the proposition was signally defeated by the return of a large adverse majority to the lower house of the Swedish Riksdag. A new tariff, embodying the extreme protective principle recently adopted by Brazil, imposes high and almost prohibitory duties on the importations of rice and all other cereals produced in the country, and, as Brazil has heretofore imported annually some two hundred thousand sacks of rice from foreign countries, the disturbance of trade in this particular is likely to be serious.

The United States having imposed heavy duties on the importations of French wines and silks, France improves on the precedent thus established, and excludes by relatively higher duties the importation into her territories of American pork. The Helvetic Confederation, in negotiating with Germany for a renewal of a treaty of commerce, broadly intimates that unless the result of negotiations is satisfactory it will take measures to check the importation of German merchandise in the future into Switzerland; while the termination by original stipulation of a treaty of commercial reciprocity between France and Italy in 1887, has been regarded with feelings of unmixed satisfaction by many persons in both countries, by reason of the opportunity that is to be afforded for mutually increasing the duties on their respective importations. A somewhat striking illustration of the present drift of popular sentiment in France on this subject is also to be found in the fact, that in July, 1887, the French Government, by a formal decree, absolutely prohibited the future importation of "plants, flowers, cut or in pots, of fruits, fresh vegetables, and, in general, of all horticultural and market-garden produce of Italian origin"; chestnuts without their shells excepted.

It is further most interesting to note how, as the idea of the desirability of restricting trade and commerce is accepted and carried out, the larger idea of the middle ages, that restrictions should be imposed, not merely on the freedom of commercial intercourse between country and country, but also between districts of the same country, and even between man and man, tends to reassert itself and demand recognition and acceptance ; as is demonstrated by a variety of incidents on both sides of the Atlantic. In this movement in Europe, France at present takes the lead. Thus, for example, French workmen and employers are apparently now in unison of opinion, that all foreigners shall be rigidly excluded from any kind of work done by or for the Government, and from furnishing any kind of supplies for the public service. Among the bills recently brought forward in the French Chamber of Deputies, and which have received the serious attention of the Government, one provides that only French coal shall be used in the navy, and only French oats in the army ; and, in general, that nothing of foreign growth or production shall be bought for public use, except such articles as are not produced in France. Clauses in existing treaties with foreign nations and apprehensions of reprisals have, it is believed, alone prevented the project of imposing special and differential taxes on all foreign workmen. The committee in charge of the French International Exhibition of 1889, while invoking the co-operation and good feeling of other countries, have restricted all bids for buildings to French firms exclusively, ruling out all foreign firms from participation in the work, even though established in France, and employing only French workmen. The ancient *guild* system of the middle ages, restricting craft-membership and the employment of apprentices, and claiming the right to exclusively regulate prices, hours of labor, and other conditions of service, is also everywhere re-establishing itself ; the glaziers of Paris leading the advance in this direction, by formally petitioning the authorities for incorporation as a guild, to which no foreigner shall be admitted, and no one not a member, even if he be a Frenchman, shall be allowed to set glass or make repairs upon windows in French territory. In a discussion of the labor-problem at a recent Catholic Congress in Belgium, the Bishop of Liege is reported as saying that the old trade-guilds must be revived and placed under the guardianship of Christian lay employers and of the clergy. Then each trade or calling must be placed under the special protection of a saint ; and brotherhoods of those engaged in it, composed both of employers and workmen, must be formed for the celebration of the saint's *fête* and for participation in religious processions and funerals, and the rendering of mutual assistance in times of need. But it was also remarked, that while labor was pretty sure to indorse the recommendation of the revival of the guild, it would be equally sure to wholly disregard the ideas of the bishop as to the uses that should be made of it. It should also not be overlooked in this connection, how closely, and yet perhaps unintentionally, the modern labor organizations—"Trades Unions," "Knights of Labor," and the like—have come to resemble and be assimilated to the ancient "*guilds*"; with this marked difference, that in the old craft-guilds, the masters or employers of labor remained in and participated in the organization; but in the modern organizations of labor, the masters or employers are especially excluded.

In Germany the extensive intervention of the state in industrial and social matters has come to be, in recent years, a fundamental policy of the Government; and is resulting in a series of experiments for controlling or even entirely absorbing great industries—as sugar and distilled spirits—and for promoting the economical and moral prosperity of the people—as schemes for compulsory insurance of life and against accidents—which have hitherto had no precedents in the legislation of any country. At the same time, in all these movements the Government makes no secret of its desire in fostering the interests of the people to at the same time augment their ability to pay taxes.

In the United States, the recent action of the French Government, in providing that nothing shall be bought for public use which is not of domestic production, and which the outside world has regarded as a policy unworthy of an enlightened nation, has had its counterpart and precedent in the previous legislation of quite a number of the States; with this exception, that in France the discrimination is made against foreigners only, while in the United States the discrimination is made against their own countrymen living in different political divisions of the country. Nothing, moreover, can probably be found in Europe to parallel the recent legislation of one of the leading States of the Northwest (Minnesota), and a large part of which was the work of a single legislative session (limited to sixty days) in 1885, and which has thus been described by a recent writer:* Prominent in importance were statutes providing for the weighing, handling, and inspection of grain; the construction and location of grain-warehouses, the providing of cars and side-tracks by railroads, and the regulation of rates of transportation. Next, was legislation respecting State loans of "seed grain" to farmers whose crops had been ruined by grasshoppers; for the subsidizing of State fairs from the State treasury; for enabling farmers to avoid the payment of a portion of their debts; for protecting butter-makers from the competition of artificial products, such as "butterine"; for regulating the details of the cattle-industry, to the extent of registering and giving State protection to brands and other modes of identification, and of stamping out contagious diseases with small courtesy to the rights and wishes of individual owners; and for regulating the lumber-business to such an extent, that not a log can float down a stream to the saw-mill for which it is destined without official cognizance. One State board regulates the practice of medicine and the admission of new

* "The American State and the American Man," Albert Shaw, "Contemporary Review," May, 1887.

practitioners; a second, the examination of druggists and compounding clerks, as precedent to entering into business; while a third regulates the practice of dentistry. Various enactments prescribe the toll to be exacted for grinding wheat; when one man may slay his neighbor's dog with impunity; how railway companies must maintain their waiting-rooms at their stopping-places for passengers; the hours of labor, and the employment of women and children; the maximum time for which locomotive engineers and firemen may be continuously employed; what books shall be used in the public schools; forbidding "raffles" at church fairs under "frightful penalties," and making it a crime to give away a lottery-ticket, and a misdemeanor "to even publish an account of a lottery, no matter when or where it has been conducted." Among bills introduced, and which found considerable support, but were not enacted, was one forbidding persons of different sexes to skate together, or even be present at the same hour on the rink floor; and another to license drinkers, which provided that no person should be permitted to use intoxicants or purchase liquors of any kind without having first obtained a public license.

The result of such a conflict of tariffs as has prevailed in Europe since 1877–'78 has entailed so much of commercial friction, such a series of retaliatory measures, and such an arrest of material development, that there are now many signs that the continuation of this state of affairs will not be much longer endurable. In this conflict, Austria, which was the first country that broke in upon the International Commercial Union that prevailed among the Continental states prior to 1878, has suffered most severely; her exports and imports having notably decreased, while her customs taxes have risen in recent years from 1*s.* 8*d.* to 3*s.* 7*d.* per head of her population, and her internal taxes on consumption from 3*s.* 7*d.* to 6*s.* 8*d.* There has been a marked decline in banking profits, an increase in the mortgages on real property, and a decline in the consumption both of meat and of farinaceous articles of food. To such an extent has her fiscal policy invited reprisals that she is described as "standing alone commercially," and reduced to the position of consuming her own products through necessity. Russia having sought to close her doors against the produce of other countries, they in their turn have curtailed their purchases of Russian products, the falling off of Russian imports—comparing 1886 with 1883—having been nearly 25 per cent, and of exports 28 per cent. Of flax, which is one of the principal exports of Russia, the decline in the value of shipments has been from $29,350,000 in 1884 to $19,250,000 in 1886. The German Chambers of Commerce, in their recent reports, have, with very few exceptions, declared against the present tariff policy as most injurious to the industry and commerce of the empire. The recent prohibitory duties decreed by Russia on the importation of iron and steel have closed numerous iron-furnaces in Silesia, and the steam corn-mills of Northern Germany are complaining of a great check to their business by reason of the duties on the import of cereals. The recent report of the Stuttgart Chamber of Commerce earnestly urges the Government to improve trade by a return to its former reciprocal conditions.*

The idea that a few years ago found great acceptance in Europe, and undoubtedly influenced the commercial policy of the different states—namely, that increased restrictions on the importation and competitive sales of foreign products and the resort to bounties on exports would conjointly stimulate industries, relieve their markets from anything like overproduction, and inaugurate a period of general prosperity—has utterly failed of realization, and been entirely different from what was anticipated. And for the following reasons: The stimulus being artificial, was unnatural. Production rapidly increased, and soon created an additional supply of articles, which were already produced in the localities best fitted for their production, in quantities sufficient, or more than sufficient, to meet any existing market demand at remunerative prices, thus occasioning an augmentation of the very evils which it was expected the restrictive commercial policy would prevent, and which may be enumerated in their sequential order somewhat as follows: 1. Overproduction in the natural seats of production. 2. Domestic competition to effect sales destructive of all profits. 3. Special concessions of prices to effect sales in foreign countries which have been disturbing to the legitimate industries of such countries. 4. A general depression of prices, and the reduction of business profits to a minimum; all resulting in a condition of affairs which two years ago is said to have drawn out from Count Karolyi, the Prime Minister of Austria, the assertion, that "the European states, by their present retaliatory tariffs, are doing themselves more injury than the most unrestricted international competition could possibly inflict."

It seems to be also now generally conceded in Germany and other states of Europe that the depression of business and the disturbances occasioned by the fall of prices, which were most influential in inducing the general reaction in favor of protective duties in 1878, were due to causes that were not to be reached by such remedies, and that

* "The result of the intensive and extensive development of the protective system," observes the Stuttgart Chamber of Commerce, "notwithstanding its beneficial influences on many branches of industry, has been to doubly increase the international uncertainty which now burdens trade and commerce. Every movement in favor of protective duties results in efforts on the part of each country interested in the matter to outbid its neighbor; and the very duty which is expected to protect a nation produces a reaction on home prices, and causes them to become assimilated to those of international commerce." This Chamber believes that the prospect of a lasting improvement in trade would "be better grounded could only further exactions in international customs tariffs be avoided, and the uncertainty of market-price, which is the outcome of the protective system, be removed by an equitable establishment of mutual customs and commercial relations, by an increased stability and certainty of the duration of tariffs, and by a reciprocal return to former conditions."

the same continue operative to-day in spite of all the customs barriers against international trade that have been erected. All the indications, furthermore, are at present in favor of a renewal of commercial treaties or alliances between the Continental states, with a view through mutual concessions, of establishing better trade-relations between the participating powers than now exist; and the announcement has been made that preliminary negotiations for this purpose have begun between Germany and Austria and Germany and Italy. One project proposed, by Professor Kaufmann, of the University of Tübingen, which has been much discussed, and the adoption of which, in the opinion of not a few, is not improbable, is the formation of a Zollverein, or commercial union, among the nations of Central Europe, with a view, as the "Kölnische Zeitung" (which is regarded to some extent as an official organ of the German Government) has expressed it, "of expanding their markets by means of treaties, so that the surpluses at any one place within their dominions may serve to make up for the deficiencies in another," and which, more especially, would "find its account in collectively fighting against economical commonwealths, like the United States, Russia, China, and Great Britain, which embrace whole continents." *

The attempt to artificially stimulate the manufacture of beet-sugar in the states of Continental Europe, and at the same time to obviate the evils from the production of this commodity in excess of local or domestic demand by the payment of bounties on its exportation, has constituted such an extraordinary factor of disturbances in the world's recent economic history as to be worthy of special narration and attention.

Although the practice of stimulating through high protective duties and export bounties the production of beet-root sugar in Europe in competition with the cane-sugar product of the tropics dates back to the first quarter of the century, the present complicated and curious state of affairs is really due to an unexpected result of the German method of taxing beet-sugar, which was adopted in 1869. The idea involved in this method was, in brief, to collect an excise or internal-revenue tax on all sugar produced; in the first instance by taxing the raw beets, and subsequently to give a drawback on whatever sugar was exported equivalent to the tax paid on the beets from which the sugar was made. At the outset about twelve pounds of beets were

* Such a formation of the "United States of Europe"—this phrase being borrowed from the "Kölnische Zeitung"—coupled with the avowed objects to be prospectively attained by it, would have a peculiar significance for the United States of America, as the feeling in Europe in respect to the export trade of the United States in respect to food-products has not been and is not now friendly. "The prohibition of her hog-products, the successive additions to the duties on grain and cattle, and the readiness with which any complaint against an American staple is taken up and widely circulated, often in a grossly exaggerated form, are indications of what would be the position of such a customs union toward the United States, could it become an accomplished fact."

required to make a pound of sugar, and on this basis the drawback was calculated; or for every hundred-weight of sugar exported, there was granted a drawback of nearly twelve times the tax paid on each hundred-weight of beets. For a number of years after 1869 this arrangement worked well, the drawback being about equivalent and no more than the tax. But nothing stimulates human ingenuity in a greater degree than the prospect of gain through the avoidance of a tax; and gradually a change in the condition of affairs took place. By careful and scientific cultivation the saccharine element in the beet was so much increased and the mechanical and chemical methods of extracting it so greatly perfected, that while in 1869 twelve pounds of beets were needed in the average German factories to make one pound of sugar, in 1878 the requisite quantity was 10·78 pounds; in 1882, 10·08 pounds; in 1884, 9·28 pounds; in 1886, 8·80 pounds. The effect of this was to make the drawback on the exports of sugar no longer equivalent to the tax, and convert it into a bounty; or the exporter received a drawback as if he had paid an excise-tax on twelve pounds of beets, when in reality he had paid on a much smaller quantity—less than nine pounds after 1885. The fact that this bounty was accruing was not unknown to the German Government; but as it became especially manifest during the years 1876–'79, when the great depression of industry had developed a strong protectionist feeling, nothing was done to stop it; but on the contrary it was popularly regarded with satisfaction. Under such favorable circumstances, the beet-root sugar product of Germany increased with great rapidity; and as the amount soon far exceeded any requirements for domestic consumption, and as a net profit of from 6 to 7 per cent was guaranteed to the manufactories by the export bounties, the exportations soon assumed gigantic proportions, rising from about 500,000 cwt. in 1876 to over 6,000,000 cwt. in 1885. The other states of Continental Europe, finding the markets for their own product of beet-root sugar everywhere supplanted by the German sugars and their domestic manufacturers being even thereby brought to the verge of ruin, made haste to follow the example of Germany, and improve upon it, by offering larger bounties for the domestic production and export of sugars than were offered elsewhere; until the policy of Germany, France, Belgium, Holland, Austria, and Russia during recent years, seems to have been to stimulate their domestic product of sugar to the greatest extent, and then enter into competition with each other to see which of them could sell cheapest to foreigners at the expense of their own people; the home-grown sugars of France and Germany, for example, selling, it is reported, in England for about one half the prices paid for the same article by the French and German people.*

* In 1883-'84, Germany, at an estimated cost of about $7,000,000 in the way of export bounties, exported more than three fifths of her annual product of beet-sugar.

The Russians determined nearly forty years ago to make their own sugar out of beet-root, and at first encouraged their manufacturers with a specific bounty. Subsequently they substituted for the bounty an almost prohibitory duty on imports, and under this system the production of beets and sugar increased rapidly for many years, with large resulting profits to producers. In 1881 the Russian manufacturers produced just enough to satisfy the demands of the home market. In 1882 there was an excess of production. Prices then began to fall and manufacturers to fail. They could not export their surplus at a profit, because they could not compete in foreign markets. More protection at home was not wanted, because the protection existing was complete. Under these circumstances application was made to the Government to pay them for exporting their surplus, and this the Government agreed to do, to the extent of giving a bounty of one rouble per pood * on an exportation that was to be limited to two million poods, with a remission also of all internal taxes on the same. This arrangement continued until January, 1886, when, the Russian market being overstocked with sugar, an extension of the bounty on an unlimited exportation was demanded, and granted by the Government for a period of about six months, or until July, 1886. The result was that the Russian exporters poured upon the English and Italian markets (the only ones readily available to them) during this brief time, and to the great disturbance of the world's markets, sugar to the amount of seven and a half million poods (227,000,000 pounds), leaving still three million poods surplus at home unsold and unsalable. The present French export bounty on sugars is estimated at from 5*s.* to 10*s.* ($1.20 to $2.40) per cwt., entailing an annual expense to the treasury of at least $15,000,000. As the French refiners, however, obtain a great quantity of untaxed raw sugars, the actual annual loss to the Government is believed to be much greater. The present export bounty in Germany is 2*s.* per cwt., and the present annual treasury expenditure, in order that foreigners may have cheap sugar, is believed to be about 37,733,796 marks, or $9,334,000. For the year 1885–'86, Austria is supposed to have paid $8,000,000; Belgium, $4,000,000; and Holland, $1,330,000, on account of sugar-export bounties. The United States, in this business of selling sugar cheap to foreigners at the expense of their own people, has also played a not undistinguished part, the exports of refined sugars having risen from 22,227,000 pounds in 1881 to 252,579,000 pounds in 1885, or 26,000,000 pounds in excess of the entire cane-sugar product of the country for the latter year. The secret of this probably was, that a bounty was paid under the guise

Of this exportation a large part went to the United Kingdom, where the average consumption of sugar for that year was in excess of seventy pounds per capita, as compared with an average of seventeen pounds for the population of Germany.

* The Russian pood equals 35 English pounds, and the single silver Russian rouble may be reckoned at 60 cents.

of a drawback, which the English sugar-refiners estimated at 39 cents per 100 pounds. This drawback having been reduced by the Treasury Department to 17 cents, the exports for the succeeding year, 1885-'86, at once fell off to 164,339,000 pounds.

The experiences that have followed this attempt, on the part of practical statesmen, to interfere with the natural progress and development of a great industry, constitutes one of the most instructive chapters in all economic history. Judged from certain standpoints, the bounty system, as applied to beet-root sugar, has been unquestionably most successful. It has increased the aggregate product of this variety of sugar so rapidly that, in place of constituting 20 per cent of the whole sugar-product of the world, as it did in 1860, it now represents at least 56 per cent of such aggregate. This artificially increased product of sugar has so far exceeded the current demands of the world for the consumption of this commodity, that sugar now ranks, in point of retail value, with such articles as oatmeal, barley, and flour; and it has even been proposed that it should be utilized as food for cattle, or as a fertilizer in competition with artificial manures. Comparing wholesale prices, sugar was 114 per cent higher in 1880 than the first half of 1887. Such a reduction in the price of a prime necessity of life has been of immense advantage to consumers. In Great Britain, whose policy since 1874 has been to give her people sugar free of taxation, the per capita consumption has risen from 56 pounds in that year to 75 pounds in 1886 (as compared with a per capita of about 54 pounds in the United States in 1885); while the saving to the British people, from the reduction of the cost of this one item of their living, in the single year of 1886, has been estimated by a good authority (Mr. Samuel Montague, M. P.) as high as £11,000,000 ($55,000,000). Again, the bounty policy developed a large local industry in many of the states of Continental Europe, and for a time paid enormous profits to manufacturers and refiners producing for export, as is believed to be yet the case in France, and which has recently increased its duties on the imports, and its bounties on the exports, of sugar, and which latter are now three times greater than those paid by Germany. During the year 1886 the profits of the two leading sugar-refiners of France from export bounties, exclusive of their domestic trade, were reported as about £150,000 ($2,225,000) each; but how much of this they were required to part with in order to force, through reduced prices, the sales of their product in other countries, is, of course, not known. It is claimed to have greatly injured the sugar-refining industry of Great Britain; but, on the other hand, it is declared to have given a great impetus to the business of manufacturing confectionery, preserved fruits, jams, etc., in that country; industries which have given employment to many more persons than were ever occupied in refining sugar.

But there is another side to this picture. Under the influence of an extraordinary and artificial stimulus more sugar has been produced than the world was ready to absorb, even at the reduced prices which the bounties made possible. The price of beet-root, and therefore of all sugar, has continued to decline, until the sugar-industry of Continental Europe (with the possible exception of France), is suffering under the severest depression. Many establishments have closed or passed into bankruptcy, and it is now well understood that the only profit available to the manufactories is that derivable from so much of their product as is exported, which, in the case of Germany, represents more than half of the annual production. In a recent discussion in the German Reichstag, Deputy Heine opposed the continuance of the present bounty system in that country, upon the ground that it was disastrous to the agricultural laborer, who had been compelled to sacrifice all his land to the beet-cultivators. These cultivators, who farmed upon a large scale, had effected many improvements in labor-saving machinery, and thus reduced the laborer's wages to a minimum; so that in some districts the laborers were little better off than serfs. At the same time the people of the sugar-producing states of Europe uniformly pay more for what proportion of their own sugars they consume than is paid by foreigners on the proportion exported. In Russia, where the depression is extreme, the manufacturers have petitioned the Government, but thus far unsuccessfully, to restrict production by law to whatever extent would be necessary to keep the price up to the point at which it stood when the domestic product was just sufficient to supply the home market; or, in other words, to permit production to continue at the producer's discretion, but not to allow him to sell anything over the regulation amount in the home market. The disaster which the extreme artificial reduction in recent years in the price of sugars has brought to other great business interests and to the material prosperity and even civilization of large areas of the earth's surface, can not well be overstated. In Barbadoes (British West Indies), in February, 1887, it was estimated* that the loss at that time on every ton of sugar produced and exported to London was £1 15*s*., and in the absence of all profit on what is almost the sole industry of the West Indies, it would seem as if civilization would disappear from many of the islands, as indeed it already has in a great degree from some of them—the island of Tortola, for example, which was, comparatively a few years ago, the seat of a profitable sugar-industry. In the Spanish islands of Cuba and Porto Rico, the taxation of sugar, mainly export duties, have hitherto constituted an important source of revenue, but within a recent time Spain, as a condition for saving the planters from ruin, has felt obliged to relinquish most of them. In Java, the situation of the sugar-industry is so deplorable that, in order to save it from destruction, with the consequent throwing of half a million of Javanese laborers out of employment, and thereby increas-

* "Barbadoes Agricultural Reporter," February, 1887.

ing the already large number of Malay pirates, the Dutch ministry, in 1886, decided, besides making advances to planters on their crops, to purchase from their colonial planters five eighths of their production at a price that would entail a sacrifice on the Dutch treasury of about 40,000,000 francs, or $8,000,000.* And since then it seems to have been well established, that German beet-root sugar has been and is now exported half round the globe, and largely sold in Singapore, the center of the great sugar-producing countries of Asia, at a price which makes its use to the manufactories of preserved fruits more advantageous than the sugars of Java and the other islands of the Indian Archipelago. A like exportation of Continental sugars, artificially reduced in price, to Australia, also threatens with ruin the developing cane-sugar industry of these countries.

Finally, the states of Continental Europe, in which the burden of taxation is already most grievous, and in most of which there is a regular and increasing annual deficit, are beginning to feel that they can no longer endure the strain upon their finances which the bounty-paying system to their sugar-industries entails, and which has not brought prosperity to them or the state. In this reaction, Russia has taken the lead, and is stopping her bounties as rapidly as possible; and all the other states exhibit unmistakable evidences of a desire to follow her example. The difficulty, however, is that so much of their respective sugar-industries as has been called into existence artificially would be immediately ruined, with great loss and suffering to a large number of people, if the bounties were at once discontinued; and the same result would follow by the putting an end to any possibility of exporting, if one, or all but one, of the states should cease paying bounties, and one, like France, should continue to do so. Earnest efforts are accordingly being made for the holding of an international congress, with the object of agreeing upon a mutual abandonment of the bounty system; and the official announcement has been made by the British Government that Austria-Hungary, Germany, Holland, Italy, Spain, Belgium, and Denmark have agreed to participate; Russia and France having not as yet declared themselves on the subject of attendance.

In face of this experience, the Government of the Argentine Republic has determined to appropriate an annual sum of $550,000 for three years, in order to stimulate the export trade of that country in beef and mutton for the European market.

The recent experience of France in attempting to stimulate ship-building and ship-using, through a carefully-devised system of subsidies and bounties, furnishes another illustration of the effect of gov-

* "Journal des Fabricants de Sucre," October, 1886.

A further idea of the depression of the sugar-trade in Java may be gained from the fact, that the imports of raw sugar from the island by Holland have declined—comparing the results of the year 1870 with those of 1885—about 90 per cent.

ernmental interference with the natural course of industries, second in importance only to that afforded by the experience of sugar.

Thus, to accomplish the purpose above noted, the French Government offered in 1881 to give a bounty of $12 a ton on all ships built in French yards of iron and steel; and a subsidy of $3 per 10 tons for every 1,000 miles sailed by French vessels; and as they did not desire to put any inhibition on the citizens of France buying vessels in foreign countries and making them French property, in case they desired to do so, they proposed to give one half the latter subsidy to vessels of foreign construction bought by citizens of France and transferred to the French flag.

At the outset, as was the case with the sugar bounties, the scheme worked admirably. New and extensive steamship lines were organized with almost feverish haste, and the construction of many new and large steamers was promptly commenced and rapidly pushed forward in various French ports, and also in the ship-yards of Great Britain and other countries. The Government paid out a large amount of money, and it got the ships. In two years their tonnage increased from a little over 300,000 to nearly 700,000 tons for steamers alone; while the tonnage engaged on long voyages increased in a single year from 3,600,000 to over 4,700,000 tons.

It was probably a little galling to the French to find out after two years' experience that most of the subsidies paid by the Government were earned by some 200 iron steamers and sailers, and that over six tenths of these were built and probably owned in large part in Great Britain; so that the ship-yards on the Clyde got the lion's share of the money. But as all the vessels were transferred to and sailed under the French flag, and were regarded as belonging to the French mercantile marine, everything seemed to indicate that the new scheme was working very well, and that the Government had really succeeded in building up the shipping of France. But the trouble was that the scheme did not continue to work. The French soon learned by experience the truth of the economic maxim, that ships are the children and not the parents of commerce; and that while it was easy to buy ships out of money raised by taxation, the mere fact of the ownership of two or three hundred more ships did no more to increase trade, than the purchase and ownership of two or three hundred more plows necessarily increased to a farmer the amount of arable land to plow; or, in other words, the French found that they had gone to large expense to buy a new and costly set of tools, and then had no use for them.

And, what was worse, they found, furthermore, that while they had not increased trade to any material extent, they had increased the competition for transacting what trade they already possessed. The result has been that many French shipping-companies that before the subsidy system were able to pay dividends are now no longer able; fortunes that had been derived from the previous artificial prosperity have melted away; the French mercantile marine has ceased to grow; and the whole scheme has proved so disastrous a failure that the late Paul Bert, the eminent French legislator and orator, in a speech in the French Assembly, seriously undertook to defend the French war of invasion in Tonquin, on the ground that its continuance would afford employment for the new French mercantile marine, which otherwise, we have a right to infer, in his opinion would have remained idle.

The experience of the mercantile marines of Europe during recent years affords the following curious results: It shows, *first*, that the payment of bounties has practically availed nothing in arresting the continued decrease in sailing-tonnage; *second*, that in the eight years prior to 1880, French shipping, in its most valuable branch—steam—increased faster than the shipping of any of its Continental competitors; but after 1880, the increase in the steam-marine of Germany, where no bounties were paid, was relatively greater both in number and tonnage of vessels than in France where large bounties were given after 1881; and was also greater as respects the aggregate tonnage of all vessels—sail and steam. The obvious expectation of the French Government in resorting to the bounty system for shipping was that ships built and navigated with the aid of the bounties, would carry French manufactures into foreign countries, and thus open new markets for domestic products. But experience, thus far, has shown that all that has been effected is a transfer, to some extent, of the carriage of goods formerly brought in foreign vessels, to French vessels. But, on the other hand, the increase of tonnage, under the stimulus of the bounties, beyond the requirements of traffic, and the consequent reduction of freights, has entailed "a loss, and not a gain to the French nation; by throwing upon it the burden of a shipping interest that, but for the Government aid, would have been unprofitable, and which, because of such aid, can not conform itself to the demands of trade." *

The experience of Great Britain, occupying as she has, the position of being the only country in the world of *large* production and commerce which has not within recent years imposed restrictions on the competitive sale of foreign products in her markets, is also exceedingly interesting and instructive. That British trade and production has been injured by attempts in the nature of forced sales on the part of competitors in protected countries to dispose of their surplus products in the English duty-free markets—while the tariffs of their own countries have shielded them from reprisals—and that from like causes Great Britain has experienced severe foreign competition in neutral markets where British trade had formerly almost exclusive possession, can not be doubted. Thus, the report of the British Commission "On the Depression of Trade and Industry" (1886) shows that the importation

* "Report on the Mercantile Marines of Foreign Countries," by Worthington C. Ford. U. S. Department of State Ex. Doc., 1886.

of foreign manufactured or partially manufactured goods into Great Britain has increased since 1870, at "a slightly more rapid rate" than the increase of its population, having been £1·97 per head in the period 1870–'74, and £2·35 per head in the period 1880–'84. The extent of the injury to British interests from these changes in the conditions of the world's trade, does not, however, appear to have been as great as might have been anticipated, or as is popularly supposed; and very curiously has manifested itself in a reduction of profits, rather than in any reduction of the volume of British trade; the value of British exports to the six protectionist countries of the world—the United States, France, Germany, Russia, Spain, and Italy—having been larger during the years 1880–'84 than in any quinquennial period of British history, with the exception of the period from 1870–'74, when British trade is known to have been abnormally inflated. It is also not a little interesting to note that the countries of the world in which, according to the most recent and accepted statistics, the ratio of wealth and the ratio of foreign commerce to the population are the greatest, are Holland and Great Britain, the two states that have emancipated themselves in the greatest degree from all restrictions on the interchange of products with foreign nations—the customs revenue of the former amounting to about one per cent on her imports, and that of the latter to about five and a half per cent.* In India, also, where there are few artificial restrictions on the freedom of exchange, internal trade, manufactures, and foreign commerce have increased in an extraordinary degree within recent years, and the wages of skilled labor have also, at the same time, notably advanced.

An analysis of the comparative values of the export trade of the nations of Europe during the five years from 1880 to 1885—a period of intense struggle for the domination of the world's markets—affords the following interesting results: In cotton and woolen yarns and dry-goods, England has strengthened her position; in iron and steel goods, her share of the world's trade has increased from 64·2 to 66·5 per cent; while in machinery her exports have been pushed up from 66·7 to 69·1 per cent. In glass and glass goods England's percentage remained constant, while that of France and Belgium declined. Germany increased her exports of glass and glassware, and also very largely of paper, and slightly of machinery, losing ground in respect to the exportation of iron and steel goods, in common with France and Austria.

* It is popularly believed that the *per-capita* wealth of the people of the United States, which the census of 1880 fixed at $860—but which, allowing for duplications, is probably not over $500—is greater than that of any other people. This, however, is not the fact; the ratio of wealth to each inhabitant in Great Britain being $1,245, and in Holland, $1,200. The wealth of Holland, moreover, doubled in the twenty years next prior to 1880, while the gain in population of the country during the same period was comparatively insignificant. In respect to commerce, the ratio to each inhabitant, in 1880, was $150 in Holland, as compared with $91 for Great Britain, and $32 for the United States.

In leather and leather goods, Germany leads, while France appears to be rapidly losing her former supremacy.

Apart, however, from their bearing on any particular country, a review of all the circumstances connected with the multiplication of restrictions on international commerce, which the majority of civilized nations have united in creating in recent years, fully justifies the British Commission and other European authorities in regarding it as a most influential agency in occasioning almost universal economic disturbance. It has been progress backward—progress in the direction of that sentiment of the middle ages, which held that, as commerce benefited one country only as it injured some other, it was the duty of every country to impose the most harassing restrictions on its commercial intercourse. Or, in other words, increased knowledge respecting the forces of Nature, and a wonderful subordination and use of the same having greatly increased and cheapened the abundance of all useful and desirable things, the majority of the world's legislators and statesmen have seemed to have considered it incumbent upon them to neutralize and defeat the beneficent results of such abundance. And the most comforting assurance that progress will not indefinitely continue to be made in this same direction, is to be found not so much in the intelligence of the masses or their rulers, as in the circumstance that existing restrictions on commerce can not be much further augmented without such an impairment of international trade as would be destructive of civilization.

As the restrictions on trade within the last eight or nine years have not been all imposed at one time, but progressively, and as their influence has accordingly been gradual, the world does not seem to have as yet fully appreciated the extent to which the exchange of products between nations has been thereby interrupted or destroyed. But as the case now stands, Russia practically prohibits her people from any foreign purchases of any iron or steel ; Germany and Austria, of cereals ; Belgium, of cattle and meats ; Russia, Austria, Germany, France, Belgium, and Holland, of sugar ; France, of pork ; and Brazil, of rice. The imports of Russia, as before pointed out, decreased twenty-five per cent in the three years from 1883 to 1886 ; those of France from $160,981,000 in 1881 to $127,457,000 in 1885 ; and those of Austria during the same period from $251,230,000 to $219,273,000. Between France and Italy trade has been interrupted to almost as great a degree as mutual governmental action will admit ; while the value of the exports of the United States to France which amounted in round numbers to $100,000,000 in 1880, had become reduced in 1886 to $40,096,000. The one objective of the restrictive commercial legislation of all countries in recent years has been mainly the United States ; and it has already affected the former agricultural supremacy of the country in the markets of the world ; the exports of cattle from the United States, comparing 1886 with 1881, having declined 35·8 per cent in quantity; of beef products 17·7 per cent, and of pork products 35 per cent. The exports of butter and cheese have also participated in the general decrease of exports.

THE ECONOMIC DISTURBANCES SINCE 1873 CONTINGENT ON WAR EXPENDITURES are not different in kind from those of former periods, but much greater in degree. This subject has been so thoroughly investigated and is so well understood, that nothing more need be said in this discussion, than to point out that the men in actual service at the present time in the armies and navies of Europe is in excess of 4,000,000, and that it undoubtedly requires the product of one operative or peasant labor, to sustain one soldier. The present aggregate annual direct war expenditure of the world is probably in excess of a thousand million dollars. We express this expenditure in terms of money, but it really means work performed; not that abundance of useful and desirable things may be increased, but decreased; not that human toil and suffering may be lightened, but augmented.

EVOLUTION AND RELIGIOUS THOUGHT.*

BY PROFESSOR JOSEPH LE CONTE.

FROM what has preceded, the reader will perceive that we regard the law of evolution as thoroughly established. In its most general sense, i. e., as a law of continuity, it is a necessary condition of rational thought. In this sense it is naught else than the universal law of necessary causation applied to forms instead of phenomena. It is not only as certain as—it is far more certain than—the law of gravitation, for it is not a contingent, but a necessary truth like the axioms of geometry. It is only necessary to conceive it clearly, to accept it unhesitatingly. The consensus of scientific and philosophical opinion is already well-nigh if not wholly complete. If there are still lingering cases for dissent among thinking men, it is only because such do not yet conceive it already—they confound it with some special form of explanation of evolution which they, perhaps justly, think not yet fully established. We have sometimes in the preceding pages used the words evolutionist or derivationist; they ought not to be used any longer. The day is past when evolution might be regarded as a school of thought. We might as well talk of gravitationist as of evolutionist.

If, then, evolution as a law be certain; if, moreover, it is a law affecting not only one part of Nature—the organic kingdom—and one department of science—biology—but the whole realm of Nature and every department of science, yea, every department of thought, chang-

* From advance sheets of Professor Le Conte's work on "Evolution and its Relation to Religious Thought," in preparation by D. Appleton & Co.

ing our whole view of Nature and modifying our whole philosophy, the question presses upon us, "What will be its effect on religious belief, and therefore on moral conduct?" This is a question of gravest import. To answer it, however imperfectly, is the chief object of this work. Except for this, it would probably never have been undertaken. All that goes before is subsidiary to this.

But I will doubtless be met at the very threshold by an objection from the scientific side. Some will say—because it is the fashion now to say—that as simple, honest truth-seekers, we have nothing to do with its effect on religion and on life. They say we must follow Truth wherever she leads, utterly regardless of what may seem to us moral consequences. This I believe is a grave mistake, the result of a reaction, and on the whole a wholesome and noble reaction, against the far more common mistake of sacrificing truth to a supposed good. But the reaction, as in most other cases, has gone much too far. There is a true *philosophic* ground of justification for the reluctance with which even honest truth-seekers accept a doctrine which seems harmful to society. Effect on life is, and ought to be, an important element in *our estimate of the truth of any doctrine.* It is necessary for me to show this in order to justify this part of my work.

There is a necessary and indissoluble connection between truth and usefulness. We all at once admit this connection in one direction. We all admit that a truth must eventually have its useful application. It may not be *now*, nor in ten years, nor in a century, nor even in a millennium, but sometime in the future it will vindicate its usefulness. No truth is trivial or useless in its relation to human life, for man is a part of Nature, and his life must be in accordance with the laws of Nature. Every one admits this, but not every one admits the converse proposition, viz., that whatever doctrine or belief, in the long run and throughout the history of human advancement, has tended to the betterment of our race, must have in it an element of truth by virtue of which it has been useful, for man's good can not be in conflict with the laws of Nature. Also, whatever in the long run and in the final outcome tends to the bad in human conduct, ought to be received, even by the honest truth-seeker, with distrust, as containing essential error. The reason of this will now be further explained.

There are three primary divisions of our psychical nature, viz., sensuous, intellectual, and volitional, or moral. There are three corresponding primary processes necessary to make a complete rational and satisfactory philosophy: (1) There is first the *instreaming* of the external world through the senses, as impressions. These we call facts or phenomena. (2) The elaboration of these facts within, by the *intellect*, into a compact constant structure. This we call knowledge. (3) The outgoing of this knowledge by the *will* into the world as right or wise conduct. Now these three are all equally necessary. All these three portions of our complex nature are equally urgent to be satisfied.

But, unfortunately, scientific workers are too apt to think only 1 and 2 necessary—that true facts elaborated into consistent theory are all we need care for. Theologians and metaphysicians, on the other hand, seem to think only 2 and 3 necessary. They elaborate a theory consistent in all its parts, exquisitely woven in beautiful and delicate pattern, and apparently satisfactory in its application to the right conduct of life, but are less careful to inquire whether it is in harmony with facts derived from the senses. But, we repeat, all three are equally necessary. The first gathers the materials, the second constructs the edifice, the third, by *use*, by practical application, *tests* whether it be a fit building to live in, whether it is constructed on sound architectural principles. The tendency of the olden time was to neglect the first; the tendency of the present time is to neglect the third. But we repeat with stronger emphasis that this third element is equally necessary. All admit that successful application in art is the surest test of the truth of science. Now, social conduct is the art corresponding to our philosophy of life, and therefore is the sure test of its truth. It follows, therefore, that unless all these three primary divisions of our nature are satisfied by any doctrine, there must result an ineradicable confusion and discord in our psychical nature, and cordial acceptance is not only impossible but irrational. We insist upon this the more because it has become the fashion in these latter days of dominance of science, to say that to inquire into effects on society is inconsistent with the scientific spirit, and unworthy of the honest truth-seeker. But, observe, I am speaking of effects on society only as a *test of truth*. I would not swerve a hair's breadth from absolute devotion to truth. It is necessary, indeed, to inquire into effects on society, but we must inquire only in the patient spirit characteristic of the truth-seeker. Whatever is really true will surely vindicate itself by its beneficence, if we will only wait patiently for final results. Evolution is no exception to this universal truth. It will surely vindicate its beneficence, but we must wait yet a little while—not very long.

So much it was necessary to say in justification of the inquiry which constitutes this third part of our work. But, after this justification, the question returns with additional emphasis, "What will be the effect of the universal acceptance of the law of evolution on religious thought, and through this on the right conduct of life?"

There can be no doubt that evolution, as a law affecting all science and every department of Nature, must fundamentally affect the whole realm of thought, and profoundly modify our traditional views of Nature, of God, and of man. There can be no doubt that we are now on the eve of a great revolution. But, as in all great revolutions, so in this, the first fears as to its effects are greatly exaggerated. To many, even friends and foes of Christianity, evolution seems to sweep away the whole foundation, not only of Christianity, but of all religion and morals, by demonstrating a universal materialism. Many are ready to cry out in anguish, "Ye have taken away our gods, what have we more? Ye have destroyed our dearest hopes and noblest aspirations, what more is left worth living for?" But I think all who are at all familiar with the history of the so-called conflict between religion and science will admit this is not the first time this cry has been raised against science. They have heard this danger-cry so often that they begin to regard it as little more than a wolf-cry—scientific wolf in the religious fold. It may not be amiss, then, to stop a moment to trace rapidly the main points of this conflict—to discuss the various forms of this scientific wolf.

First, then, it came in the form of the *heliocentric theory of the planetary system*. We once thought the earth the center of the universe, and so firm that it can not be moved. But science shows that it moves about the sun, and spins unceasingly on its axis. Every one has heard of the terror of the sheep produced by this discovery, and the nearly tragic results to the bold scientist. But now we look back with wonder that there should have been any trouble at all. Would any Christian now consent to give up the grand conceptions of Nature and of God thus opened to the human mind—the idea of infinite space full of worlds, of which our earth is one, moving in silent harmony as in a mystic dance? Verily, this wolf has proved itself a harmless, nay, a very noble, beast, and lies down in peace with the lambs.

Next, it came in the shape of the *law of gravitation*, as sustentation of the cosmos by law and resident forces. The effect of this on religious thought was even more profound, though less visible on the surface, because only perceived by the most intelligent. It seemed at that time to remove God from the course of Nature. This was the real ground of the skepticism of the last century, and also the real motive of Voltaire's ardent advocacy of Newton's views before these were generally accepted in France. But now, who would give up this grand idea—this conception of law pervading infinite space—the same law which controls the falling of a stone guiding also the planetary orbs in their fiery courses? This is indeed the divine spheral music, inaudible but to the ear of science, accompanying the celestial dance.

Next, it came in the form of the *antiquity of the earth* and of the cosmos. The earth which we had fondly thought made specially for us about six thousand years ago; sun moon, and stars, which we had vainly imagined shone only for our behoof—these, science tells us, existed and each performed its due course inconceivable ages before there was a man to till the ground or contemplate the heavens. Some of my readers may still remember the horror, the angry dispute which followed the promulgation of these facts. But now, who would consent to give up the noble conception of infinite time thus opened to our human mind and become forever the heritage of man?

Next it came in the form of the *antiquity of man*. It is probable, nay, certain, that man has inhabited the earth far longer than we had previously supposed we had warrant for believing. The fear of controversy on this question has indeed not yet entirely subsided. Some timid people still look askance at this wolf, but I think all intelligent people accept it and find it harmless.

Next, and last, it comes now in the form of *evolution*—of the origin of all things, even of organic forms, by *derivation*—of *creation by law*. We are even now in the midst of the terror created by this doctrine. But what is evolution but law throughout infinite time? The same law which now controls the development of an egg has presided over the creation of worlds. Infinite space and the universal law of gravitation; infinite time and the universal law of evolution. These two are the grandest ideas in the realm of thought. The one is universal sustentation, the other universal creation, by law. There is one law and one energy pervading all space and stretching through all time. Our religious philosophy has long ago accepted the one, but has not yet had time to readjust itself completely to the other. A few more years, and Christians will not only accept, but love and cherish this also for the noble conceptions it gives of Nature and of God.

But some will exclaim, "Noble conceptions of God, say you! Why, it utterly obliterates the idea of God from the mind. All other conflicts were for outworks—this strikes at the citadel. All others required only readjustment of claims, rectification of boundaries betwixt science and religion—this requires nothing less than unconditional surrender. Evolution is absolute materialism, and materialism is incompatible with belief in God, and therefore with religion of any kind whatsoever!" Before proceeding any further, it becomes necessary to remove this difficulty out of the way.

GLIMPSES OF LIFE ALONG A CORAL REEF.

By F. H. HERRICK.

LAST summer (1886) I spent the month of June, with a party of naturalists from Johns Hopkins University, on Green Turtle Key, a small coral island near Abaco, Bahama, where we were engaged in the study of marine invertebrate life. In order to learn more of the general flora and fauna of the reef, I visited many of its rocks and keys which stretch in a long, broken chain northeastward of Abaco and the submerged banks connected with it. My friend who accompanied me was especially interested in birds, and was anxious to obtain specimens of the eggs and skins of the sea-fowl which breed in great numbers on these remote islands.

Abaco Island is roughly crescent-shaped (as shown by the accompanying map), its two horns pointing about northwest and south.

With Little Abaco, which properly belongs to it, it is nearly one hundred miles long, and has an average width of twelve miles. There are six hundred and eighty square miles in the larger island alone. The greater part of its outer side, facing the ocean, is bordered by an inner reef of small keys and rocks, which trend northwest by southeast,

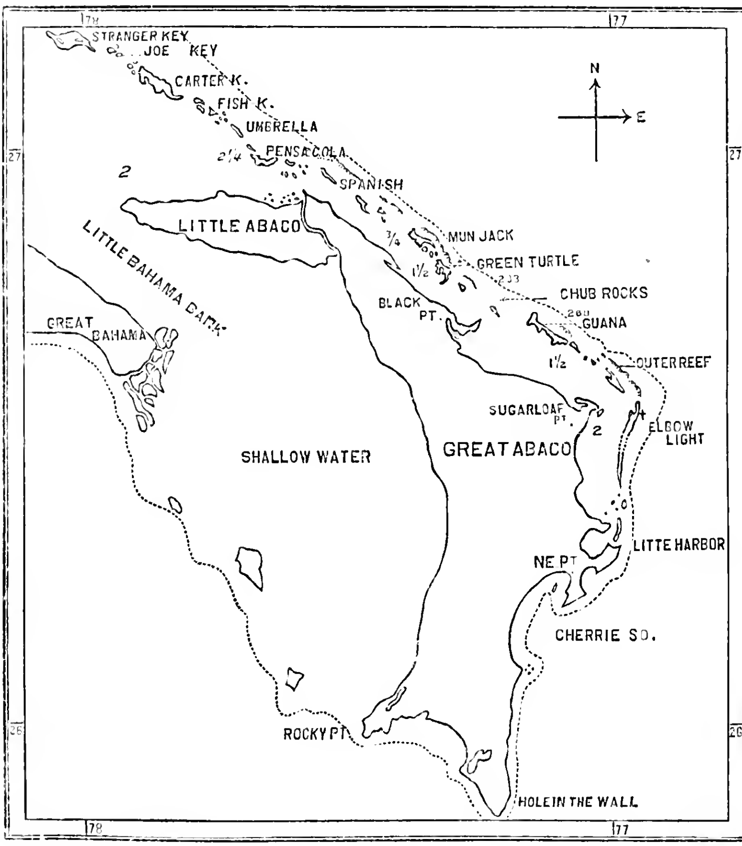


FIG 1.—MAP OF ABACO ISLAND AND ITS ADJOINING REEF. (From the latest United States Coast Survey Chart).

and form a channel about five miles wide, having a depth of from one to two and a half fathoms. Two or three miles farther out there is a second reef, mostly submerged, beyond which the bottom falls abruptly to the abyssal sea. The larger islands extend through one degree of latitude, from nearly 25° 50′ to 26° 50′.

We left Green Turtle on the 15th of June in a sail-boat, with two men to pilot and assist us. Our older guide, Curry, was a native of the island, and made his living by fishing and sponging. His services were invaluable, as he was not only invariably obliging, but knew every rock and key in the reef, and could readily tell them at a long distance by their slight differences in contour. The position of our key, which we had left behind, was shown by the top of its tall cocoanut palms long after the island itself had dipped below the water. Taking a northwest course up the channel, Abaco is seen as a low barrier on our left, while at a greater distance it looks like an undulating green ribbon between the sky and sea. We pass numerous small keys

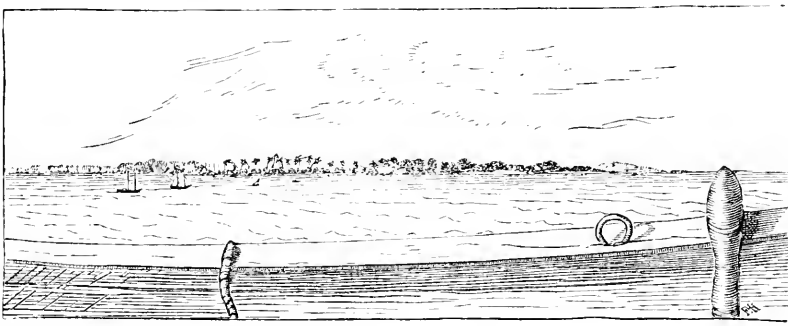


FIG. 2.—GREEN TURTLE KEY, BEARING THREE MILES NORTHEAST. (From a sketch made from the deck of a schooner.)

and rocks on the right, between which long white lines of breakers may be seen, marking the outer reef. We are frequently near enough to the "mainland" to see its dense forests of pine, its palms fringing the shore, the narrow beaches of white coral-sand, with here and there a thatched hut fronting a pineapple field, which may be distinguished by the small clearings in the woods.

The keys present the greatest variety in size and form, from a bare rock no larger than a buoy to islands five or six miles long. The latter are very narrow, and are usually covered with a thick growth of shrubs and small trees which, excepting a few palms, rarely exceed fifteen or twenty feet in height. The islands are scattered along closely together, or occasionally separated by wide channels. The soil has to be very thin indeed, which can not support a variety of shrubs, which seem to grow out of the very rocks and to live upon the air. Some of the smaller keys are mantled with vines and climbing plants, such as smilax, convolvuli, and rock samphire, with here and there some low shrubbery at the water's edge.

The coral-rock which forms the basis of the islands crops out at many points, and is always exposed around the shores where these are not covered by a sand-beach. Freshly-broken surfaces have a light-cream color, but weather to a uniform grayish tint. This limestone is so soft that it can be readily sawn or chopped with an axe. Consequently, the waves denude it rapidly, forming the white coral-sand, which is distributed as a fine deposit over the sea-bottom and as stretches of smooth beach. The shores overarch where they are at all precipitous, roofing a wide cavern below, in which the ceaseless roar of the waves may be heard at a long distance. Where a single rock stands alone, it is usually so much undermined that it resembles a low table with a single huge leg. There is a large perforation through the rocks at the southern extremity of Abaco, known as the "glass window," and also several submarine passages extending from one side of the island to the other. The rain carves grotesque forms out of the soft stone. This is sometimes coarsely honeycombed, or bristles all over with pinnacles or miniature chimneys, which are sharp as knife-edges, and compel you to use much caution in walking.

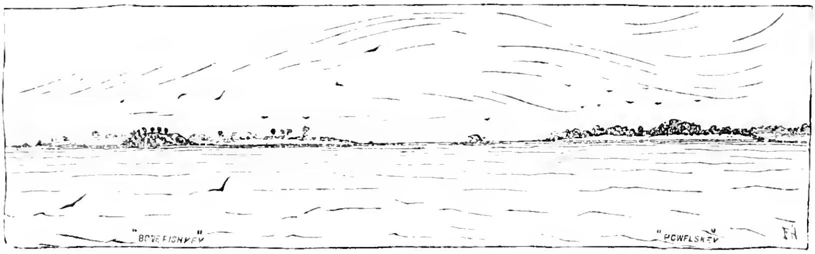


FIG. 3.—TWO CHARACTERISTIC CORAL KEYS AS SEEN FROM OFF THE NORTHEAST COAST OF ABACO. (The tallest trees are Cocoanut Palms. The eroded table-shaped rock between the islands is from a sketch made at another point.)

The dark-green foliage of the keys is frequently bordered by white, glistening lines, indicating beaches of coral-sand, which reflect the sun's rays with great power. Cocoanut palms find foothold along the shores, growing spontaneously from nuts cast up by the waves. In going northward from Green Turtle we pass successively Crab, Fiddle, Mun Jack, Ambergris, Spanish, Pensacola, Umbrella, Fish, Carter, Joe Keys, etc., and, in an opposite direction, Pelican Key, No Name Key, Great Guana Key, and numerous others.

The sharp contrast between the ordinary "white water" of the bay and the deep blue of the sea beyond the reefs, is very striking. The irregular black patches seen everywhere in the channel are due to algæ or similar plants growing on the bottom. The sea-floor between Abaco and the reefs is elsewhere covered with the white coral-sand which causes a marvelously brilliant color-effect in strong lights, the tints ranging from the richest emerald to a transparent greenish-white.

Numerous sea-fowl show themselves as we sail past their haunts: brown pelican, standing immovable like statues on the rocks, but suddenly expanding into birds of astonishing size; men-of-war or frigate birds, whose dark, cleanly-cut forms are strongly silhouetted against the sky; flocks of black-headed gulls, standing in military order, each facing the same way, on the rocks, rise and whirl off at our approach.

At Fish Key we found a large colony of the sooty terns (*Sterna fuliginosa*), or "egg-bird," as the natives call them, just beginning to breed. This is a collection of wild-looking rocks, rising ten or fifteen feet above the sea like a row of petrified sand-dunes, which in reality they probably are, and covered with low shrubbery, grasses, and vines.

When a long way off we noticed the birds hovering over the place, and on landing, their numbers increased until the air far above and around us fairly swarmed with the gliding forms of this graceful tern, and the strange medley of their harsh cries, together with the whirring of thousands of wings, was nearly deafening. They were nesting amid a tangle of shrubs three or four feet high, along a low, narrow ridge of one of the islands, a few yards from the water. Parting the bushes aside, we could see the old birds sitting on their eggs, and caught with our hands several which were snared in the vines as they attempted to fly. This tern resembles a large and powerful swallow. It has a sharply-forked tail, snow-white neck and breast, while the rest of the plumage is a dead black. They nest close together under the bushes, laying a single egg on the ground, without nest of any kind. Their eggs are easily distinguished from any others which we saw, being white or creamy and boldly spotted all over with umber and lilac. Even in these remote places the numbers of sea-birds are being yearly lessened by the natives, who persistently collect their eggs for food. The rare flamingo is now reduced to a colony of a few hundred on Abaco, where, as I was informed by an old settler, they numbered thousands several years ago, and similarly the beautiful tropic bird, which is hunted chiefly for food, is being gradually exterminated.

Close beside this key there was a small rock a few yards square, with scarcely a spear of grass upon it, which a party of the Wilson's tern (*Sterna hirundo*) held in undisputed possession. Their cone-tipped, olive-green, and spotted eggs lay in twos and threes on the bare surface of the limestone. Both this bird and the smaller edition of it, the least tern (*S. superciliaris*), which has similar habits, are called "shanks" by the islanders, while on the North Carolina coast (where we found both species breeding a month before) they are known to the fishermen as "great" and "little strikers." The Wilson's tern has a wide range, and is one of the most beautiful of a large and exceptionally striking family. It has a prominent black crest and coral-red bill and feet. Like many of our most attractive birds, it is shot down each season to satify the widespread demands of a barbarous fashion. Its pearly wings, or as often the whole bird, usually much distorted by the milliner, may be seen almost any day in the streets, pinned on to ladies' hats.

As we approached Paw-paw Key some tall bushes on the island appeared to be draped in deep mourning. Presently, as a large black company of birds rose one after another in the air, we recognized the frigate-bird (*Tachypetes aquilus*). I counted seventy of them as they soared above our heads. These swarthy giants cut a memorable figure against the sky, with their great angular wings, and long, forked tail. They mount slowly upward in spiral curves, with all the ease and grace of the hawk, until a safe height is reached, when they sail rapidly off to a distant island. The females are recognized by a conspicuous white spot on the breast. We witnessed the ascension and retreat of this pack from the same key on our return a few days later.

This little island is nearly bare except for the carpet of vines and low bushes. A few specimens of the *Conocarpus*, called here "button-tree," are growing along the water's edge. It is ten or fifteen feet high, and may be easily told at a glance by its silvery foliage. Its flowers are inconspicuous, in small globular heads, but they are quite fragrant. This and the *Rhacichallis rupestris*, called "seaweed" by our boatmen, are characteristic of all these islands. The latter is semi-prostrate, and has fine, spray-like foliage, resembling an evergreen. Its light-gray bark is noticeable and also its small saffron flowers. This shrub is very common on the exposed rocks just above high-tide mark, where various mollusks are found in great numbers. One univalve (*Tectarius*), nearly an inch long, is especially abundant. The rocks are peppered with them, and clumps of several hundred together are sometimes seen. It climbs up the stems of the Rhacichallis, on which it probably feeds, and seems to derive a double protection, from the colors of both the coral-rock and bark of this shrub, which it perfectly simulates.

Before landing at this key we had seen a large, black bird emerge from a mass of twigs in a bush overhanging the water, and, with its long neck outstretched, fly to an adjacent part of the island. This proved to be the Florida cormorant (*Phalacrocorax*) and its nest. I soon saw a number of these birds standing in line on a sand-spit with heads erect, like a squad of soldiers at drill. The nest was a shallow, rudely-built platform of twigs and grass, and contained three long,

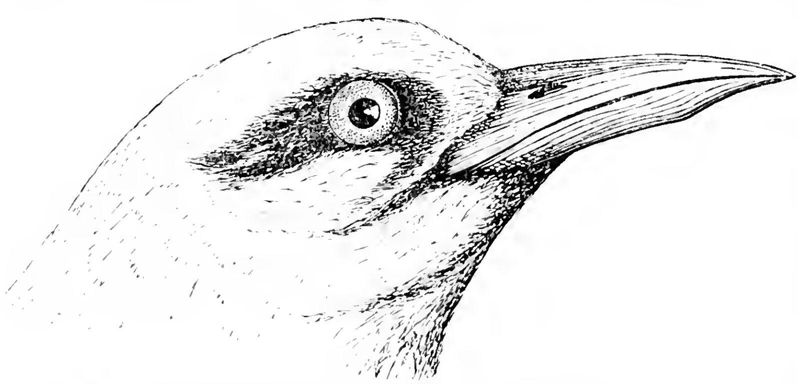


FIG. 4.—HEAD OF THE YELLOW-BILLED TROPIC BIRD (*Phaëton flavirostris*). (Three fourths natural size. From a sketch made by Mr. A. H. Jennings.)

bluish-white eggs, of a coarse, chalky texture. We found several nests on the island, most of which had been just completed. The long neck and thick stub of a body gives the cormorant a comical appearance, whether it is on the wing or walking erect on the beach. This species has sooty-black plumage, a yellow throat, and a blue rim round the eye. The bill is long and cylindrical, the upper mandibles curving over the lower in the form of a sharp hook, and the lining of the mouth and gular-pouch is bright blue. The long, black quills of the frigate-bird were scattered over the island, and the bushes were whitened with their ordure.

I had not been many minutes on the key before I discovered a large snow-white bird nestling on the ground under a spray of Rhacichallis. Its wings were barred with jet-black; its bill was bright yellow, and tapered to a spear-like point, which forbade too close familiarity. This proved to be the yellow-billed tropic-bird (*Phaeton flavirostris*), and we afterward caught several in our hands, taking them from the nest. When held up by the wings, they strike lustily with their bills and utter a peculiarly shrill cry. The tropic-bird lays a single egg on the ground beneath rocks or bushes. It is about the size and make of the hen's, and is finely sprinkled with reddish-brown, so as to appear of an almost uniform tint. One of these birds which my companion shot and slightly wounded, flew a short distance and then alighted on the water. As we sailed toward it, first one and then another bird came and hovered over it as if urging it to take flight, which it presently did, and with its attendants soon passed out of sight. These birds resemble the gulls in many points, but are distinguished from other sea-fowl by two long streamers in the tail, which wave behind them as they fly.

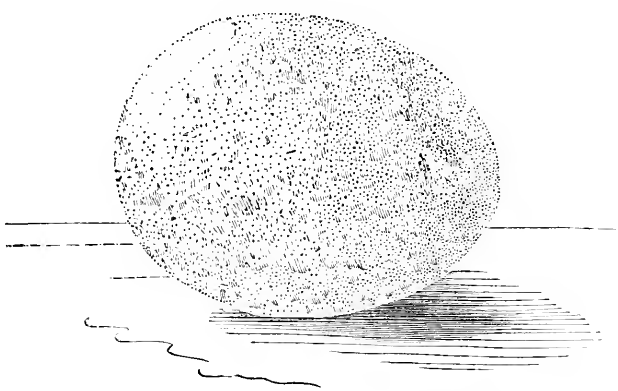


Fig. 5.—The Egg of the Yellow-Billed Tropic Bird. (From Paw-Paw Key, natural size.)

Joe Key, forty miles northwest of Green Turtle, was the most interesting island we visited. Its windward side, facing the sea, is rocky and precipitous. A mangrove-swamp nearly divides it into two, and on the inside there is a smooth beach and a good harbor for small boats. It was nearly dark when we landed, but our attention was soon called to the great numbers of pigeons which were constantly flying to and fro from one point to another on the island. Before going ashore, we rowed to a narrow inlet between a detached cliff and the main island, through which the tide flowed with a rapid current. Fish may be always found at such places, where they are apparently on the lookout for the food swept back and forth by the tides. Here our guides captured two fish in as many minutes, which were more than enough for our breakfast and supper. The largest of these was the grouper (*Epinephelus morio*) a thick, powerful fish of a dull, reddish-olive color, with a square tail like a cod. The other, the barracouta or sennet (*Sphyræna picuda*) has the shape of a pike. Its jaws are armed with long, projecting teeth. Neither of these fish are especially esteemed, but of the two the barracouta is the best. The inhabitants of these islands capture most of their fish and the turtle with the "grains" or spear. A water-glass also is usually carried in the boat. The grains is an awkward weapon, but in skillful hands a most effectual one, consisting simply of a spear-head attached to a rope, at the end of a long pole.

Above the sand-beach there were two small springs, where our guides scooped up enough water to fill a small keg. These were merely holes dug in the sand scarcely above high tide, and contained decidedly brackish rain-water, which, however, could be rendered palatable by boiling and by the addition of lime-juice. The swamp was bordered by an almost impenetrable growth of shrubbery and small trees, in which were hundreds of old pigeons' nests. The ground was literally strewed, particularly under the trees, with an interesting species of hermit-crab, which inhabits the empty shells of a common whelk. These crabs are of a chocolate-brown color, and have one large swollen claw. They are exceeedingly active, climbing steep surfaces with ease, and probably ascend trees.

We could hear the whirring of hundreds of pigeons overhead, and their peculiar cooing, *cu-oo-cu-oo-cu-hu-hu*, which has a singularly melancholy sound in the woods at dusk. It is impossible to see out of these tangles where the branches and vines interlace over your head, and it is sometimes necessary to climb up and take your bearings. At the hour of twilight the pigeons are approached without difficulty. Besides the white-crowned pigeon (*Columba leucocephala*) there was also another species, called the "rock dove." The former is of a nearly uniform plumbeous blue, excepting its snowy crest. The rock-dove is more brilliantly marked with brown, and iridescent green and blue. It is a pretty sight to see hundreds of these birds sitting erect on the trees, and to watch their rapid, incessant flight. If one is disturbed, all within gunshot take wing, and circle rapidly over the trees, sometimes encompassing the island before settling again. These birds were apparently about to breed here very soon.

There was a palmetto-grove on this island, in which a recent fire had burned away all the undershrubbery, leaving a clean floor to walk upon, and the charred trunks and new foliage of some of the palms showed how closely they also had escaped. These trees have great size of trunk compared with their height, which gives them a decidedly dwarfed appearance. Some swollen boles, a foot or so in diameter, are only four or five feet tall. A pendulous spray of fine creamy flowers hangs down from the base of the leaves. This is succeeded by a small nut or berry, dried specimens of which were still on the trees. Many of the trunks were tattooed by a woodpecker, which also breeds on the island, as shown by its old nesting-holes.

The mosquito, which abounds everywhere along the keys, did not trouble us here, but the pest of the place was a microscopic midge, called the "sand-fly," with black head and transparent body, whose burning touch was like that of a sharp needle on the skin.

The Bahaman red-winged starling, looking much like our northern species (*Agelaeus phœniceus*), of which it is a variation, was common, and probably breeding on this key. It delivered its flute-like *warble-ee* as assiduously from the top of a palm as its relative does his from the button-bush or alder of a New England meadow.

The black-headed or laughing gull (*Larus atricilla*) was nesting here also, as well as at most points where we touched. It is a common resident all along the South Atlantic sea-board. We found its nests and eggs at Portsmouth, on the North Carolina coast, the last week in May. It is easily distinguished by its black hood, which completely covers the head, ending abruptly on the neck. This cap is, however, exchanged for a white one in winter. These birds dwell in small colonies on the rocky keys, nesting a few feet above high-water mark. The nest is indifferently made of grass and seaweed, varying much in the amount of materials used, and contains from two to three large, olive eggs, mottled or spotted with darker pigment.

A handsome spike-grass (*Uniola paniculata*), whose wavy plumes are sometimes six feet tall, grows above the sandy beach. This same species occurs along the coast from Virginia to the Gulf of Mexico, where it is called "sea-oats." The green blades of the "West Indian lily" (*Pancratium Carolinianum*), a member of the Amaryllis family, are found growing in large clumps at the water's edge. Its flowers, which were now nearly past, are pure white, and remarkably fragrant. We found here also the *Sabbatia gracilis* in the sand, and a small leguminous tree, with clusters of reddish flowers, at which I saw the Bahaman honey-creeper—a delicate little warbler—busily at work.

The Cuban nighthawk (*Chordeiles minor*) was breeding here, as at several other islands which we examined. It is called "pilepedick," from its peculiar note, which is well reproduced in the name. It has many of the characteristics of the bull-bat of the Eastern United States, tumbling along the ground as if its wings and legs were broken, if surprised on its nest, and producing that peculiar booming sound when on the wing by sweeping down from a great height in the air. The young, which we found as frequently as the eggs, resemble a pinch of gray down, and so perfectly do both they and the eggs match the gray rock on which they are laid, it is only by a rare chance if you find a nest without flushing the old bird. The young nighthawk is about as broad as long, and, unlike the callow young of most birds, it is covered from head to foot with a thick coat of down.

On our return we anchored the first night in a little harbor at Allons' Key, where two small fishing-boats had already taken refuge from a threatening squall. We saw the ruins of several huts on this island, and the remains of a small grove of cocoanut trees, which had been blown down in the destructive hurricane of September, 1884. The place was so infested by mosquitoes that this little settlement had to be abandoned. It rained heavily in the night, but our men took an early start, and awoke us the next morning at five by announcing the discovery of a

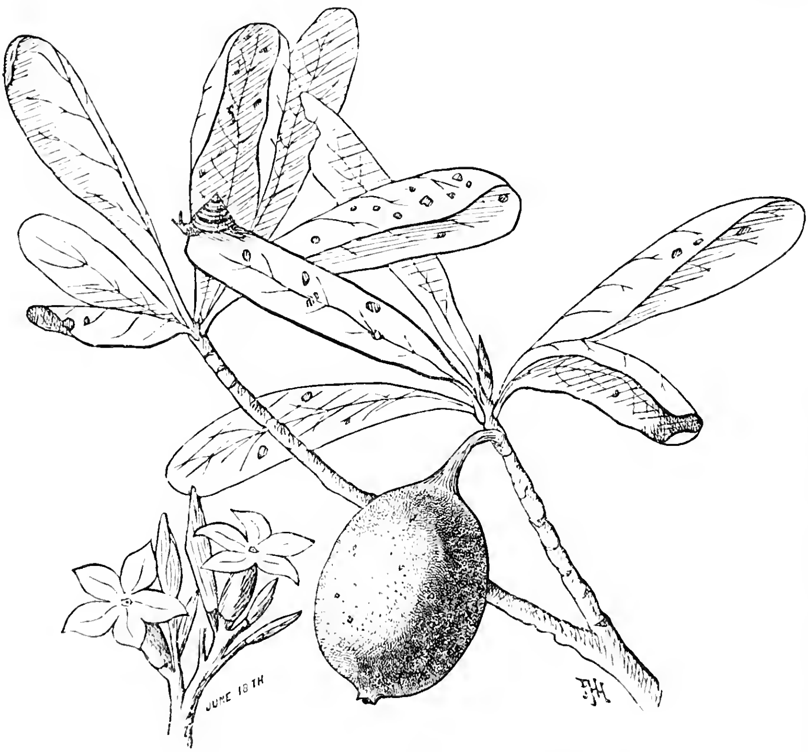


Fig. 6.—Fruit and Flowers of the Seven-Year Apple (*Genipa clusiifolia*). (One half natural size.)

"loggerhead's track." The beaches had been leveled by the rain, so that any new impression could be readily seen. The turtle had ascended the beach to a point above high tide, had stirred up the sand, leaving a great heap over her eggs, and returned to the water but a short time before we landed. This was shown by the ebbing tide, which had retreated only a short distance from her last tracks. The eggs were laid in a bunch, and covered with sand a foot and a half deep. There were just one hundred and thirty-nine of them. They resemble a white rubber ball, an inch and a half in diameter. The sea-turtle's eggs have a peculiar flavor, but are very palatable. The glair becomes tough and leathery by boiling, and is always thrown away. The breeding-season of the loggerhead (*Chelonia caretta*) lasts from May well into August, according to the statement of our guide, who also said that they deposited eggs several times in this period, producing as many as one hundred and eighty at the first laying, and perhaps no more than two or three at the last. The natives make a business-like search for these eggs each year, and sometimes surprise the female turtle on the beach. When she has once begun the egg-laying process, it has to be finished, even if she is turned on her back and made a prisoner immediately after. The extraordinary egg-producing power of these animals is all that preserves them from immediate extinction.*

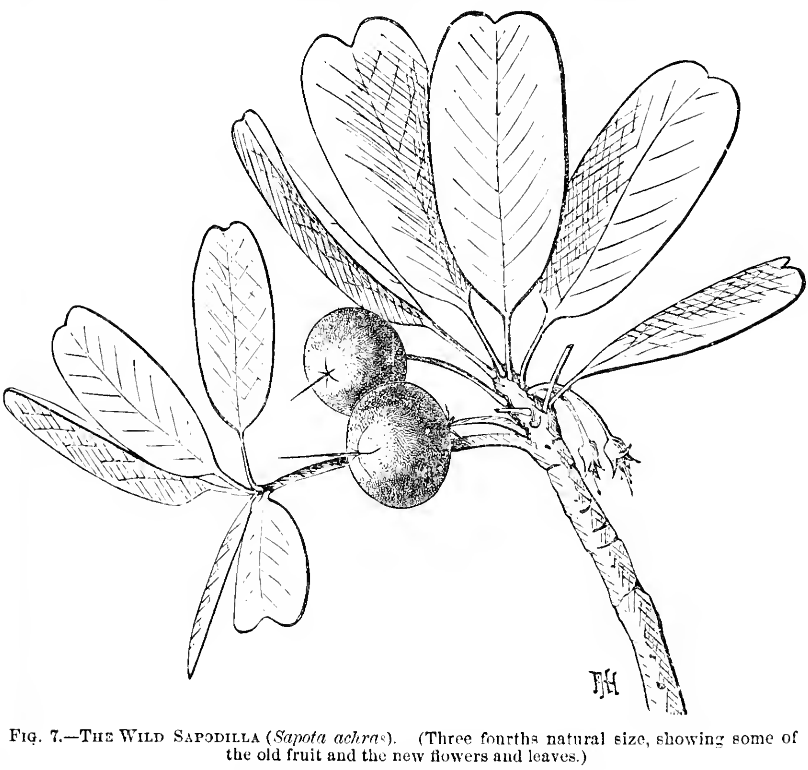


FIG. 7.—THE WILD SAPODILLA (*Sapota achras*). (Three fourths natural size, showing some of the old fruit and the new flowers and leaves.)

Large forest-trees, such as pine, cedar, and mastic, which grow on Abaco, do not occur on the keys. We find here, however, smaller trees and shrubs in great variety. Besides those already mentioned,

* Some time ago a large grouper was speared by a fisherman off Sand Key near Nassau, and twenty-two young loggerheads were found in its stomach. This fish was doubtless feeding along the shore, and had evidently snapped up the young turtles just

there are three palmettos, called the "silver" and "thatch-top palms," and "hog-cabbage"; "sea-grape" (*Coccoloba uvifera*); the "seven-year apple" (*Genipa clusiifolia*); *Malvaviscus arboreus*, a handsome shrub, with red flowers, resembling a small hollyhock; mangrove (*Rhizophora mangle*); wild sapodilla (*Sapota achras*); and many others equally characteristic. Land-snails are very common on some of the islands, and the omnipresent lizards (*Annolis*) were the only reptiles which we met with.

The Genipa or seven-year apple is very abundant along the shores of the islands just above high-tide mark. It sends up from the ground slender brittle stems a few feet high, bearing creamy-white flowers and a hard, yellowish-green fruit, which is inedible. The leaves are dark green and highly polished.

The wild sapodilla is equally common, and attains the height of a small tree. The axillary flower-clusters appear a little in advance of the leaves, which in June add a touch of the brightest spring green to every thicket. The fruit, which is not edible, is covered with a rusty-brown skin, and is usually terminated by the long persistent style. The cultivated sapodilla forms a good-sized tree, and appears to grow spontaneously wherever it has been introduced. It differs from the former chiefly in point of size and in the superiority of its fruit. Possibly the wild form is the parent stock from which the other, with its sweet, pulpy fruit, has been derived; but I have been unable to gather any facts relating to this point. A milky juice flows freely from the wounded bark of the sapodilla-trees, forming a viscid gum, which the negroes use as bird-lime. It is also noteworthy that the *Isonandra gutta*, a Malayan tree, from the juice of which the gutta-percha of commerce is obtained, is also a member of the *Sapotaceæ* or Sapodilla family.

These islands have been largely colonized from the South, principally perhaps from Cuba; and the Gulf Stream and other agents, which have brought the plant-germs thither, have carried them also to the keys and coast of Florida, where they may have first become established. The seed-eating birds, finches and starlings, which are common on Abaco and many of the small islands, serve also as important distributors of grains and seeds of other plants. The great number of shrubs bearing edible berries may be partially accounted for in this way. The annual hurricanes, on the other hand, are certainly powerful agencies in scattering seeds over wide areas. Knowing the frequency of their occurrence and their long duration, we can see how by this means alone an island would soon acquire a rich and varied flora.

as they were making their *début* in the water. Thus it seems that these animals have to contend with enemies which are even more formidable than man, and it not surprising that this valuable and once staple product of these islands is fast becoming a luxury.

THE PSYCHOLOGY OF JOKING.

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

PUNNING, I think, does not receive enough attention. In spite of Dr. Johnson's well-known dictum, we should not despise punning. Sydney Smith says that it is the foundation of all wit. Supposing three degrees of evolution, I submit that punning is the least evolved system of joking, that wit is evolved out of punning, and that humor is evolved out of wit. Everybody has heard of Sydney Smith's remark—that it requires a surgical operation to get a joke into the head of a Scotchman. But he spoke without distinguishing. The Scotch have a great appreciation of those highly-evolved jocosities displaying the humorous, although, no doubt, a scorn of simple, lowly-evolved jocosities, such as plays on words. It is difficult to form a conception of a Scotch punster. Yet I have heard an Aberdonian, a physician of world-wide reputation, make a pun.

Punning is well worthy of the psychologist's attention. I seriously mean that the analysis of puns is a simple way of beginning the methodical analysis of the process of normal and abnormal mentation. This, I think, I can easily show. Vision is stereoscopic: in a sense it is slightly diplopic, for there are two dissimilar images, although there seems to be but one external object, as we call it. To borrow the ophthalmological term, we can say that mentation is "stereoscopic"; always subject-object, although we often speak of it as single ("states of consciousness," etc.). Just as there is visual diplopia, so there is "mental diplopia," or, as it is commonly called, "double consciousness." Now I come back to punning. We all have "mental diplopia" when hearing the answer to a riddle which depends on a pun—"When is a little girl not a little girl?" Answer: "When she is a little horse (hoarse)." The feeble amusement we have in the slightly morbid mental state thus induced is from the incongruous elements of a "mental diplopia." The word "hoarse" rouses in us the idea of a little girl who has taken cold, and the same-sounding word "horse" rouses in us the idea of a well-known quadruped at the same time. We have the sensation of complete resemblance with the sense of vast difference. Here is, I submit, a caricature of the normal process of all mentation. The process of all thought is "stereoscopic" or "diplopic," being the tracing of relations of likeness and unlikeness.

To call punning a slightly morbid mental state may be taken as a small joke, but I do not think it very extravagant to describe it so; it certainly is not if it be a caricature of normal mentation. A miser has been defined as an amateur pauper; the habitual drunkard is certainly an amateur lunatic; and in the same style of speaking we may say that—well, we will say that punning is playing at being foolish; it is only morbid in that slender sense. The word "play" carries us forward in a slightly different direction. Jocosities of all degrees of evolution—(1) puns, (2) witticisms, and (3) humorous statements—are the "play of mind"; play in the sense in which the word has been used in the remark that the "æsthetic sentiments originate from the play impulse." A further definition of play as thus used is given in the following quotation from Spencer: "The activities we call play are united with æsthetic activities by the trait that neither subserve, in any direct way, the processes conducive to life."* There would be a great intellectual advance—due, I presume, to internal evolution—when man began to value things for their beauty apart from their use, one sign of his having "got above" his mere animal self. For it showed that, over and above mind required for mere animal existence, he had some surplus mind for greater ends of life. So I contend that our race owes some respect to the first punster. For the dawn of a sense of the merely ridiculous, as in punning and the simplest jokes, shows the same thing as the dawn of æsthetic feeling—surplus mind, something over and above that required for getting food and for mere animal indulgence. All the more so if punning be that out of which wit and humor are evolved. It is not a good sign if a man be deficient in humor, unless he have compensation, as Wordsworth had, in a sense of the sublime, or in great artistic feeling, or in metaphysical subtlety. The man who has no sense of humor, who takes things to be literally as distinct as they superficially appear, does not see fundamental similarities in the midst of great superficial differences, overlooks the transitions between great contrasts. I do not mean *because* he has no sense of humor, but because he has not the surplus intellect which sense of humor implies. Humor, being the "play" of mind, is tracing deep, fanciful resemblances in things known to be very different. This is "playing" at generalization, and is only a caricature of the same kind of process which made Goethe declare that a skull is a modified part of a vertebral column.

Now I am about—not really digressing from what I have just said—to say something which sounds very paradoxical: that persons who are deficient in appreciation of jocosities in their degrees of evolution, are in corresponding degrees deficiently realistic in their scientific conceptions. One would infer this *a priori*. Every child knows that a man born blind has no idea of light; but the educated adult knows, too, that the congenitally blind have no notion of darkness. And I think that observation confirms what *a priori* seems likely—that *pari passu* with the evolution of the sentiment of jocosity (playing at unreality) is the evolution of power of realistic scientific conception—from sense of the merely ridiculous with parallel realistic conception of simple things, up to sense of humor with parallel realistic conception of complex things. But we must be on our guard not to take

* "Principles of Psychology," vol. ii, p. 627.

commonplace realism about simple things to be realism when applied to very complex things. It seems at first glance more realistic to suppose that sourness is inherent in vinegar than that it is always a sensation in some percipient. But that the former hypothesis is very unrealistic is easily seen when we put such crude metaphysics in other words; the doctrine then is that part of the taster's own mind is outside himself. It is possible for the same person to be truly realistic in simple things, and to be intensely unrealistic in complex things. Thus, the really practical man, who may tell us that he despises metaphysics, may be crudely metaphysical when he deals with complex things—"explaining," for example, that a man comatose does not move because he has lost consciousness. Surely the truly realistic conception is that the comatose patient does not move any of his limbs from some physical disability—for essentially the same reason that a hemiplegic man does not move his arm and leg.

I now go back to my small joke that punning is a slightly morbid mental state, a "mental diplopia," a caricature of the normal "diplopia" of healthy mentation. From this point I make the assertion that the "physiological insanity" of dreaming is diplopic—a caricature of that of waking mentation. A physician reads in the day of the strained relations of European states; in his dream at night he is called in consultation by Bismarck, and advises a course of the iodide of potassium (directions for the application of the remedy were not given). Clearly, there are here two very dissimilar mental states "pretending" to be stereoscopic; manifestly a seeming fusion of ideas of prescribing for a patient with ideas of the attitude of European states. I hope some time to be able to show that such diplopia has the same kind of mechanism as that of the pun—that the two elaborate dissimilar states are held together by two same, or similar, simple mental states. I go on to remark that in some people there are beliefs as incongruously diplopic as some states in dreams—diplopic in that way to other people, at any rate:—(1). Killing a rabid dog to prevent people already bitten by it going mad. (2). Imagining it to be possible to study what are called "diseases of the mind" methodically without distinguishing between the physical and the psychical. (3). A cleanly mother, from maternal solicitude, refraining from washing the top of her baby's head, lest it should come to have "water on the brain." (4). Imagining it to be possible to investigate complex subjects without the use of hypotheses; for instance, that Harvey could have made observations and experiments to *prove* the circulation of the blood without *supposing* beforehand that it did circulate. (5). Anointing a blade with healing salve to cure a wound inflicted by the blade.

Once more I go back to punning for a new start, trying to show again by very simple cases that punning is only a caricature of, and therefore for the psychologist a valuable experiment on, the process of normal mentation. I take first a case which is almost if not quite a pun, but one made unwittingly. What is called the inelegance of using the same word in one sentence, or in two consecutive sentences, causes mental diplopia. For even if each of the two words has the same dictionary meaning, we must bear in mind that a word loses something of that kind of meaning when forming part of a proposition, losing and taking meaning by and from its context. Hence the second time the word comes there is a faint revival of the ideas it symbolized when used the first time, along with a vivid revival of other ideas it now symbolizes; there is trivial confusion from slight mental diplopia, like that from an ill-understood pun. I now give a more striking example—one in which there is manifest diplopia without confusion.

A smell, say of roses, I now have makes me think of a room where I passed much of my time when a child. Here clearly is "mental diplopia," and the mechanism of it is quite similar to that of the pun, making allowance for caricature in the latter. For the true process is that the smell of roses, now having, develops what we call the same smell, but really another smell, that of roses once had, in the old room. The two scents, linked together, hold together two dissimilar mental states (1) present, now narrowed, surroundings, and (2) certain vague quasi-former surroundings. When the scent of hay, or the caw of rooks, rouses in us vague pleasurable feelings, the mechanism is of the same kind, but the process is more complex. To further insist on the fact that mentation is stereoscopic, with more or less manifest diplopia, I give an example of mentation which is exceedingly common. While writing I suddenly think of York Minster. Here is manifest mental diplopia (1) narrowed consciousness of my present surroundings, with (2) cropping-up of consciousness of some quasi-former surroundings. Of course something, whether I can mentally seize it or not, in my present surroundings, has developed a similar something associated with York surroundings.

Recapitulating, I can say that the process of all thought is double, in degrees from a stereoscopic unity of subject and object to manifest diplopia (two objective states for one subject). The process of all thought is tracing relations of resemblance and difference, from simplest perception—to say what a thing is, is to say what it is like and unlike—up to most complex abstract reasoning. The formula of the caricature of the normal process of thought is the "pretense" of some resemblance between things vastly different—from punning, where the pretended resemblances and real differences are of a simple order, up to humor, where both are highly compound. We have the "play" of mind in three degrees of evolution, three stages of increasingly complex incongruousnesses.

If I had time, I could, I think, show that this address on jokes is not itself merely one big poor joke, but that what has been said applies closely to the study of "mental symptoms" in serious diseases. I should begin the new stage of the inquiry with the quasi-healthy feeling of "reminiscence," clearly an element in a mental diplopia. For my task would be an endeavor to show that all morbid mental states are departures from normal (stereoscopic) mental states in particular ways—that, for example, the process of mentation in the maniac is but a caricature of stereoscopic and diplopic mentation in healthy people. Thus, the reminiscence, although it is almost pedantic to call it morbid, is really a link between perfectly normal and decidedly abnormal mentation. For reminiscence occurs in slight attacks of a certain variety of epilepsy, as do other voluminous mental states ("intellectual auræ"): I call them all "dreamy states." These cases I should take next. There is clearly in them morbid mental diplopia, and yet this is traceably only a gross caricature of normal mental diplopia, being linked on to it by the reminiscence occurring in people we call healthy. And I think we may show that it has the same mechanism that puns have. Next, taking these miniature and transient cases of insanity, and other cases commonly called insanity, I should try to show that the comparison of mentation with vision is of direct value. In the symptomatology of a patient who has paralysis of an ocular muscle there are many elements. There is morbid visual diplopia; in insanity there is morbid mental diplopia. The ophthalmologist's "true" and "false" images have their analogues in the "true" and "false" mental states in the cases of epilepsy mentioned. In the former, when the divergence of the eyes is slight, there is more visual confusion; in the latter, when the dissolution of the highest centers is shallow, there is more mental confusion. In the former, when the divergence is great, diplopia ceases (the patient, the ophthalmologist says, "neglects" the false image); in cases of epilepsy, upon deeper dissolution than that with which there is the "dreamy state," the actions are considerably coherent. The "erroneous projections" of the former have their clear analogues in the hallucinations of many cases of insanity. Believing that all diseases are to be looked on as flaws in different parts of one evolutionary system, I urge the "Comparative Study of Diseases of the Nervous System." I submit that, recognizing the enormous difference between insanity and ocular paralysis, a profitable comparison and contrast may, nevertheless, be made, which will further a better knowledge of both. I do not mean simply that ocular paralysis may be taken as an illustration to simplify explanation of a case of insanity, but also that, both being examples of dissolution, the very same principles are displayed in each.—*Lancet.*

The Bishop of Manchester preached recently that the criticisms of men of science had induced Christians to modify some of their old views derived from the Bible. A closer study of the book showed that there had been evolution in religion—a gradual and orderly development by which people were led to the truth as they could bear it.

RAILROADS AND TRADE-CENTERS.

By APPLETON MORGAN.

IF, a century or so from now, a student of the political history of the United States shall ask, How happened it that its Congress was once moved to establish a court of star-chamber aimed at an industry not ordinarily operated except by charter; a court which was to be not only an oyer and terminer, but an inquisitor of its own motion; which should dispense with due process of law or with any process at all; which should supply penalties, civil, criminal, and as for contempt with plentiful liberality; but never assume, nay, never so much as hint or suggest a probable or even possible protection or premium upon any probable or even possible good or useful thing to be by any accident done or subserved by that industry—if, we say, the political student should ask that question, in view of the fact that no public interest seemed to have required such a statute, and that its immediate effect was to raise freight rates to the people passing the law—the lawyer of that date might suggest possibly that an application of the rule of interpretation, which provides that the intention of the framers of a statute may be looked into (under certain restrictions), would be most likely to furnish some sort of a clew.

Should the inquirer then cast about for this intention, he might perhaps light upon the following (which I clip from a morning paper):

"*Springfield, Ill., June* 30.—At a meeting of the Illinois Grain Merchants' Association yesterday, Senator Cullom was called upon to speak on the Interstate Commerce law. He said: '. . . The requirements of the law that all charges shall be reasonable, and that there shall be no unjust discrimination or unreasonable advantage or preference in favor of any person or place, had been shown by the character of the complaints against the enforcement of the act to be absolutely demanded.' In reference to the long and short haul clause, he said: '*For many years the railroads of the country have so absolutely controlled our interstate commerce that we have no means of knowing what are the natural channels of trade, or what would be the effect of the natural laws of trade upon many, at least, of the present commercial centers.* What the critics of the law call *natural centers of trade are centers created by railroad favoritism which has diverted trade from its natural channels into artificial ones at the expense of less favored localities.*'" [The italics here are ours.]

In reading the above, the student of political history aforesaid might be led to remark that to centralize and to submit to the espionage of a simple paternal commission of this Government, not only the entire railway interests of the United States (being its operation of 125,379 miles of railway, with a funded debt of $3,669,005,722, upon which interest is to be earned), but the minutest daily detail of such operation, is a rather costly method of gratifying a single Senator's or even a whole Congress's laudable curiosity as to "what are the natural channels of traffic, or what would be the effect of the natural laws of trade upon many, at least, of the present commercial centers"; and that it appears to be a rather cool proposition to charge the cost of gratifying the aforesaid curiosity upon the only party who had betrayed no curiosity in the premises whatever, but kept on its even tenor, operating at its own cost the franchises the people had given it, and endeavoring to pay one and one third per cent on the capital it employed.

But, to drop the student of political history, it is important, it seems to me, for the present generation to know, at last, just why the Interstate Commerce law was passed, and for just what sins of the railways they have been put under pedagogical surveillance. *It is because these wicked railways have been creating trade-centers!* The revelation is a particularly startling one, because among the railways themselves the maxim had always been to try and accommodate themselves to such trade-centers of the country as already existed at any possible expense and at all hazard. No terror of injunctions out of chancery were too terrible; no right of way was too costly; no rivers too broad; no mountains too solid; but the railway must supermount and penetrate, at whatever expense, to reach the trade-center which Nature had already provided. This, I say, has always been the maxim of the railway company: "Do the business of your territory, count first cost of construction as absolutely nothing. A railway is a means of supply to a trade-center, or a connection between two or more trade-centers. The product of the country must have its best markets, but those best markets are at its trade-centers; at all odds we must get to them. No matter where the president of the company lives, or where the capital is subscribed. Construct our line to the best market!" Such, practically, have been the directors' and the promoters' instructions. And, indeed, it has always seemed to be supposed, even outside of the magic circle of the railway companies, that the capital to build railroads was subscribed on the understanding that they were to do the public business, and not operate against it and in its teeth, and that it would be unnecessary demonstration of corporate idiocy to attempt to procure capital upon any other. But now comes Senator Cullom with his proposition, and we are advised that we have all been wrong; that, instead, these naughty railways have been at work not connecting but CREATING trade-centers!

Had anybody but one of the fathers of the Interstate Commerce Commission made this statement, not much attention might have been paid to it. Every railroad man—certainly every shipper over a railway—knows that the establishment of a trade-center is a matter entirely out of the power and beyond the control of railway companies not only, but of any known human power; a matter regulated by the unwritten laws of trade, laws not only unwritten but, except in their operation, entirely unknown; a result and not a process. Let Senator Cullom, for example, try and establish a trade-center, and he will speedily recognize the impossibility of it. And did Senator Cullom try, it would not be the first attempt. There are plenty of platted cities and towns to-day in the United States which have been laid out to make grass grow in the streets of actual cities in whose favor Nature and geography long ago decreed that they should be, in deed and in truth, trade-centers; and the platters, their successors and assigns, yet feel the hiatus made in their bank-accounts by payment for the costly honor of making valuable suggestions to the attraction of gravitation.

I need not, I suppose, refer, for example, to the plethora of "cities" and "city sites," whose prospects the vast dockage and trade territory of Chicago has superseded. But the force, the unwritten law, that has twice built the city of Chicago within the memory of men just entering middle age, was not devised by human brains. Perhaps a better answer to Senator Cullom's remarkable proposition about "trade-centers" could not be devised than a brief tracing of the operations of this law in this very building and rebuilding of a geographical trade-center of this continent. And if it shall be said "even if human laws did not build Chicago, a lack of exact knowledge of this operation and an interstate jealousy of their inevitable result contributed to the building," yet that ignorance and jealousy, it may be replied, were a part of the result of the working of the law, rather than of the process by which it worked.

No human foresight placed Lake Michigan where it is. But human foresight did perceive that somewhere near its foot a great commercial center must some day arise. Various points were selected by shrewd pioneers; and if the reader will take down his map he will find them still indicated upon it—Milwaukee, Racine, Kenosha, Waukegan, and Michigan City were perhaps the most promising of these (the latter especially, since here was the very foot of the great trunk or tongue of navigable water which penetrated from the north into the rich central ridge of the nation, along which its integral artery of inland communication must run, and from whose head great navigable wings were spreading east and west). Yet, while all these points were selected, somehow the swamp where Chicago now lies was carefully avoided. But it seems those natural causes which we call laws of trade were in operation; the heavy settlement of the Ohio Valley sought its outlet on the lakes, and somehow the first practical expression of that search—a railroad—capped, not Milwaukee, Racine, or Kenosha, but the swamp where rose Chicago. And now occurred a wonderful thing. The jealousy of those lake-ports, which the laws of trade had passed aside in favor of Chicago, began to operate. Each of these lake-ports saw the increasing prosperity of Chicago, and each and every one of them fell into the very error which Senator Cullom cherishes to-day. In almost his exact language each one said to itself —You people who are rushing to Chicago to build your docks and elevators are poor deluded creatures, who "have no means of knowing what are the natural channels of traffic." Those railroads are fooling you. Don't go to Chicago. Here at Racine, at Kenosha, at Milwaukee, is the place for your capital. Here is where the great development is to be. (There was no Interstate Commerce law then, but here was its spirit, and its root was, as perhaps a generation later, jealousy pure and simple). But somehow the capital still poured into Chicago ; its docks and elevators multiplied. What was the next step of the jilted towns? Each went to work ; each for itself built a railroad of its own, mortgaging the property of its citizens, issuing its bonds, pledging its credit, and multiplying its taxes to pay for it. What was the result? Simply that the wheat and corn and produce which had come to each of these ports to be loaded into ships—thereby making the trade on which the town lived and fattened in moderate prosperity—now having a cheaper transit to a larger and therefore better market, went where?—went to Chicago! In other words, these cities had destroyed themselves—impoverished not only their citizens, but loaded their successors with debt—not to increase their own prosperity, but that of hated Chicago! They had tried to fight the inexorable laws of trade and of trade-centers, and had been ruined in the attempt. The West is not free to-day from the effects of this lake-side effort to guide and assist the natural laws of trade. Money is yet being paid annually into New York trust companies in the vicinity of Wall Street by these same small lake cities (many of which by the prevailing of better counsels have become manufacturing towns of wealth and importance), as their yet uncompleted penance for believing in their own wisdom as against the unwritten statutes of the universe ; and if Senator Cullom sincerely believes that trade-centers can be created by human foresight, he can—by following up the map in the direction I have indicated—find many students in the hard school of experience willing to enlighten him.

It has been the bulk of criticism against the Interstate Commerce law, not that it was unconstitutional, but that it was an attempt to equalize by statute what Nature and cosmic forces has rendered unequal ; that it was Geography and not the railways which had established sea-ports and lake-ports and river-ports ; and that—since the sea, the lakes, and rivers did not as a rule charge more for a short than for a long haul—it was putting the statute-book of the United States into the position of a bull warning off comets, to give a railroad a franchise *to live* with one hand, and with the other to brandish a sword over it if—in operating its franchise—it compete with its competitors! But the bottom objection on the part of the people to the railway companies which has produced the Interstate Commerce law, lies unconsciously far deeper than that. It lies in the fact that the laws of trade invariably select the same points for trade-centers that Nature herself has first selected. New York, Boston, Baltimore, New Orleans, San Francisco were trade-centers before railroads were devised. When a trade-center was wanted on Lake Michigan, Chicago was selected, not by men, but by the force of natural laws. What the capitalists called a "swamp," and so avoided, was really a business plain. Sand drifted in, and built a bar before Michigan City; at certain other lake points the bluff, crumbling constantly into the lake, imperiled the harbors; other natural causes worked away at others. The cosmic forces were at work in favor of Chicago, and Chicago was elected trade-center of the majestic West. In other words, it is simply because *it can not* dispense with the discriminations of Nature that the people are disappointed with the railway as an institution, and so propose to vent their disappointment by enacting laws bristling with penalties, but nowhere promising them protection; putting their affairs into the hands of non-experts, and calling them to penal and paternal account for every breath they draw. If Senator Cullom seriously believes that the railroads have created the trade-centers of this continent arbitrarily, let him tell us why every railroad company in the country is willing to spend millions of dollars in order to get into such cities as New York and Chicago? Could a railroad create a trade-center as easily as Senator Cullom imagines, it would certainly come cheaper to that company to make a trade-center of their own than to buy their way—against every known legal, commercial, political, and geographical obstacle—into one already established.

The Pennsylvania Railroad Company was built by Philadelphia capital; certainly it did not desire to discriminate against Philadelphia. If railroads can make trade-centers where they like why did not the Pennsylvania Railroad create a trade-center for itself in its own City of Brotherly Love? The Lehigh Valley Railroad Company is a loyal Pennsylvania corporation, and its owners are natives there and to the manor born. Why did not the Lehigh Valley Railroad Company make for itself trade-centers on its own line, where land was cheap, instead of crowding into New York City at one end and into Buffalo at the other, at enormous cost? The Grand Trunk Railway is a British institution built to foster the interests of Great Britain's greatest colony, at the direct expense of its greatest commercial rival in the world's family of nations—the United States; why does not the Grand Trunk road make for itself commercial centers at Montreal or Toronto or Hamilton or Ottawa or Windsor? Why has it spent millions of good honest British gold in buying its way into Chicago at one end and Boston at the other? If, the moment railways were organized, they set the laws of Nature and of man alike at defiance, and began "to divert trade from its natural channels into artificial ones at the expense of less favored localities," as Senator Cullom boldly charges, why is the Baltimore and Ohio Railroad, owned in Baltimore, and largely by that city itself—a corporate pet of the State whose securities are a legal investment for trust funds—expending its earnings and surplus like water to parallel the Pennsylvania in a territory requiring massive construction, and fighting not only that corporation, but the State of New Jersey, in order to get into the city of New York at one end, as it has succeeded in getting into Chicago at the other? Why not save your millions, gentlemen managers of the Baltimore and Ohio Railroad Company, and build a few trade-centers for yourselves at small expense? Senator Cullom says it is simplicity itself to make an artificial trade-center; that railways have not only had no difficulty in doing it, but have actually and tortuously thereby diverted trade from natural trade-centers to the artificial ones created by themselves. Why not, then, scatter as many trade-centers as your business requires along the line of your railroad, and grow opulent beyond the dreams of avarice by doing business between them, with no possible competition to intrude and make you afraid? Seriously, is it not common information on the subject that the laws of trade are as inexorable as those of gravitation, and that it is simply impossible for human ingenuity to create a trade-center or to destroy one already made by Nature? Yea, and, moreover, that not only are human beings unable to shift the trade-center, but they can not even alter the local commercial centers of a trade-center. When Chicago was wiped out by conflagration it occurred at once to certain clever owners of real estate in the neighborhood of the heart of the city—within the city lines, and of easy communication therewith—that their opportunity had arisen. Instead of buying land in the old business centers at ten thousand dollars a foot, and spending a reasonable fortune in carting away *débris* before beginning to erect new walls let us go to work at once and build on our own lands, they said; the trade of this vast metropolis can not wait, it will come and transact itself on our premises as soon as completed. What was the fact? The clever ones built well and richly, and sat within and wooed the commerce of Chicago to change its seat. But they wooed in vain. The commerce of Chicago transacted itself knee-deep in its own ashes, and in tents and hemlock shanties, until it could re-rear its own palaces over its own head on the very spot where it had thrived before, and refused to hear the voice of the real-estate charmers, who disappeared in bankruptcy and disappointment as the result of trying even to move the sites of the local habitations in which the commerce of a city dwelt. And their successors have not yet forgotten the experiments of their principals. And so it is throughout the continent. The honest farmer in Vermont or in Central Illinois does not perhaps grumble because a few superficial feet of land on the East River, in New York City, or on the Chicago River, in Chicago, are worth more for trade purposes than the aforesaid honest farmer's acres in his interior precincts. But he does complain, and, what is more, makes his complaint a political engine for passing Interstate Commerce and "Granger" laws, when he finds that his produce can not be marketed anywhere except upon these very few square feet, and that the railway will persist in charging him more money to haul his product from Vermont to New York, or from Central Illinois to Chicago, than it does to carry it to the heart of the great American desert, if he shipped it so. Is it not true that it must cost more to go where everybody wants to go, than to go where nobody wants to go? Is there, in other words, a mundane condition in which the laws of demand do not regulate the laws of supply; and, interchangeably, the laws of supply the laws of demand? Surely, it seems a kindergarten sort of business to even ask the question; and yet, honestly, is not this the very bottom of the non-railroad public's objection to railroads (their unconscious objection, no doubt, but still their objection and their grievance), viz.: that, after all these years of railroads, the business centers are just where they always were—New York, Boston, Chicago; that the railroads *have not* diverted the business of the continent from the trade-centers and planted them elsewhere, and so given other merchants than those of the first commercial center a chance to grow rich? Is it not, in other words, not *because they have*, but *because they have not* made arbitrary centers and "diverted trade from its natural channels," that they are put under the centralized dictatorship and power of an Interstate Commission? The Almighty set the bounds within which the Atlantic Ocean and Lake Michigan roll and fret. If Senator Cullom states facts when he says that railways built by human hands can divert trade from its natural channels and create by favoritism natural centers of trade, then it is unjust and monstrous that these railroads should still operate themselves on the Scriptural principle, "that to them that hath shall be given, while from them that hath not shall be taken away even that they hath"; and still wickedly cater to the Atlantic Ocean and Lake Michigan ports (which were there before the railways were built), instead of equalizing matters and making trade-centers for the interior where there are no Atlantic Oceans and Lakes Michigan. Why should the railroads cruelly carry trade to and from those ports which are already trade-centers by reason of their waterways? Let the railroad companies be just and fair. To be sure, railways in Europe still despotically carry to Liverpool, Antwerp, Marseilles, but this is a land of equal rights. Let all its citizens have equal privileges, and equal opportunities of getting rich. The New York merchant and the Chicago merchant have grown rich because they have the Atlantic Ocean and Lake Michigan over which to do business. Now let the railways (who have only, according to Senator Cullom, to turn their hands over to oblige us) build some trade-centers for the honest farmer, or the interior merchant. Let us have as many trade-centers as we have watering-places, for example, until this nation, where the people make the laws and own themselves, becomes the land of trade-centers! And if the coarse and brutal railway company—owned by the grasping and bloated capitalist, the heartless Gould, or Vanderbilt, or Huntington, or Garrett—will not give us any trade-centers, let us petition the Interstate Commerce Commission, that these men and their soulless companies cease to dominate and despotize over this republic, and build us trade-centers wherever we want them; and, if they then refuse, let the Commission itself designate the points where our trade-centers shall hereafter erect themselves, and to which our railways shall build their track.

The simple, honest truth is that railways, like natural persons, must live by doing what is set before them; that however their tariffs are regulated, whether discriminations by rebates and drawbacks are allowed or disallowed, whether they are ordered to charge more for the long haul or the short, whether passes are given to shippers or refused—the railway must do the business the people bring to it, or go into bankruptcy and wind up. If grain seeks Chicago, if beef seeks New York, if cotton seeks New Orleans—to Chicago, New York, and New Orleans must the railway haul these products. It can not carry them to Milwaukee, to Albany, to Mobile. And, moreover, to pay its fixed charges, the railway company, like any natural person, must take the business it pays it to do, and reject that which will not pay it. Neither a railway company, nor all the railways on this continent, nor yet the Interstate Commerce Commission, nor any merely human agency, can make a trade-center. It is a disappointment, no doubt, that this is so; that toward points already favored with ample water communication, and to those only, will railroads extend their tracks, and ultimate their systems. But, even though that disappointment be crystallized in penal and prohibitory legislation, such indeed has always been the vital principle of self-preservation in the railway, as in the human system: and such, indeed, I fear (especially since Judge Deady has held judicially that railways have a right to live), will always be the rule, whether or no this people's antidote for their disappointment be to place the railroads in charge of changing Administrations at Washington, or whether tariffs will be more reasonable when left to politicians than to railway experts.

An English writer maintains that international arbitration must take the place of war, because war costs so much more than it used to do. The expense of war in the middle ages was limited to the men it killed, the property it actually destroyed, and the value of the industrial occupations the soldiers were withdrawn from. Now the burden of even a local war of relative insignificance is felt in every quarter of the world; and important business enterprises at the antipodes may be ruined by conflicts which in the old days would hardly have been heard of outside of their immediate scenes.

RACE AND LANGUAGE.*

By HORATIO HALE.

ETHNOLOGY has been defined, briefly, as "the science of the races of men," and, more fully, as "the science which treats of man as a member of a tribe or nation, and of his culture, morals, and language." Many treatises on this science have been given to the world by scholars of the first eminence, from the days of Camper and Blumenbach to our own time. But, when we examine their works, we are struck by the fact that no two of them are agreed on the mere elements or fundamentals of the science. If we inquire, for example, the number of the races of men, we find that Virey is satisfied with two, and Cuvier with three—that Linnæus makes four, Blumenbach five, Buffon six, Peschel seven, Agassiz eight, Pickering eleven, Friedrich Müller twelve, Bory de St. Vincent fifteen—while Morton increases the number to twenty-two, Crawford to sixty, and Burke to sixty-three. If we seek the criteria by which the races are distinguished, we discover that one high authority proposes the color of the skin, another the texture of the hair, another the shape of the skull, and a fourth mere geographical location—while others combine with one or more of these distinctions the minor characteristics (as they deem them) of language, stature, and mental traits. On the most important question of all, the question whether the races of men are distinct species or simply varieties, the votaries of the science are divided into opposing camps. In the latest works of the most distinguished anthropologists, we find the views of the monogenists and the polygenists as far apart and as decided as they were fifty years ago.

The question naturally arises whether a study which has no established principles and no accepted classification can rightly be dignified with the name of a science. Writers whose opinion on such a question must be received with respect have been inclined to answer it in the negative. Eminent among these, from the position which he holds, must be ranked the distinguished chief of the American Bureau of Ethnology. "There is," declares Major Powell, in a late number of "Science" (June 24, 1887), "a science of anthropology, composed of subsidiary sciences," which he enumerates. "There is," he continues, "a science of sociology, which includes all the institutions of mankind; there is a science of philology, which includes the languages of mankind; and there is a science of philosophy, which includes the opinions

* This paper (under the title of "The True Basis of Ethnology") was read, in part, before the Section of Anthropology, at the last meeting of the American Association for the Advancement of Science, when it called forth an interesting discussion. It is now presented in a fuller form, with additional evidence and arguments, which may answer some of the questions then raised.

of mankind; but there is no science of ethnology, for the attempt to classify mankind in groups has failed on every hand."

No one who reviews the latest works on this subject can deny that the opinion which Major Powell thus expresses, with a conscientious frankness that does him honor, is fully justified by their contents. And it should be added that he has not been the only one, or the first, to express this opinion. Among those who have written on this subject, no one has achieved a higher reputation than Oscar Peschel, whose too early death deprived the world of a master in this branch of study. In his well-known work on "The Races of Men and their Geographical Distribution"—a work unsurpassed for wide research and acute insight—he passes in review all the physical traits which have been proposed as means of race-distinction, and finds them all insufficient. He concludes his chapter on the subject in terms as decided as those of Major Powell. "In summing up," he says, "we must needs confess that neither the shape of the skull nor any other portion of the skeleton has afforded distinguishing marks of the human races; that the color of the skin likewise displays only various gradations of darkness; and that the hair alone comes to the aid of our systematic attempts, and even this not always, and never with sufficient decisiveness. Who, then," he adds, "can presume to talk of the immutability of racial types? To base a classification of the human race on the character of the hair only, as Haeckel has done, was a hazardous venture, *and could but end as all other artificial systems have ended.*"

If all artificial systems of classifying human races have ended in failure, shall we renounce all attempts at such classification, and affirm that there is no such science as ethnology? Or shall we endeavor to discover some natural method by which the numerous varieties that we all recognize in the populations of the globe can be clearly and positively distinguished and classified? We have a notable example set before us in the history of another science, which from a crude and hopeless chaos—made by centuries of the acutest study and observation only more confused, irrational, and perplexing—was suddenly, by a single discovery, transformed into one of the clearest, most regular, and most fruitful of sciences. When Aristotle pronounced that all substances were derived from four elements, fire, air, earth, and water, the science of chemistry may be said to have been as far advanced as was that of ethnology when Linnæus made his four divisions of humankind into the white European, the brown Asiatic, the red American, and the black African. Nearly twenty-two centuries passed from the time of Aristotle before Lavoisier, Berthollet, Gay-Lussac, and, above all, Dalton, discerned the true physical elements and their modes of combination, and thus made chemistry a science.

Many scholars have sought to find in language the basis of a natural classification of the races of men. Their attempts have thus far been frustrated by various causes. One of these has been the ignorance which has until lately prevailed in regard to the number and true character of the existing linguistic stocks. It is not very long since most philologists seemed unable to extend their views beyond the Aryan, Semitic, and Chinese families of speech. All other idioms were looked upon as little better than formless gabbles, unworthy of serious study. Duponceau, the father of American philology, was the first to bring to the notice of scholars the important fact that among the languages of America there are some which in happiness of construction and in power of expression deserve to rank as high as the Indo-European tongues, and far higher than the Chinese or even the best of the Semitic languages. His assertions, though confirmed by abundant evidence, were long in overcoming the earlier prejudices. But they are now accepted by the highest authorities. More than fifty years after the date of Duponceau's first treatise, Professor Max Müller expressed his surprise that "this most tempting and promising field of philological research has been allowed to lie almost fallow in America—as if these languages could not tell us quite as much of the growth of the human mind as Chinese or Hebrew or Sanscrit." And to emphasize his meaning he adds: "To my mind the structure of such a language as the Mohawk is quite sufficient evidence that those who worked out such a work of art were powerful reasoners and accurate classifiers." * Not less decided is the opinion expressed by Professor Whitney, in his "Life and Growth of Language," concerning the Algonkin speech. "There are," he writes, "infinite possibilities of expressiveness in such a structure; and it would only need that some native-American Greek race should arise, to fill it full of thought and fancy, and to put it to the uses of a noble literature, and it would be rightly admired as rich and flexible, perhaps, beyond anything else that the world knew." Nor is it only in America that languages of this superior quality are found. Dr. R. N. Cust, in his work on the "Modern Languages of Africa," has given us the opinions expressed by the able French and English and American missionaries and grammarians who have written on the remarkable Mpongwe language, spoken on the western coast of that continent, near the equator. They speak, with one accord, of its "beauty and capability," its "elaborate structure and musical tone," its "regularity, exactness, and precision," its "order and philosophical arrangement," and especially its "wonderful capacity for conveying new ideas," making it needless for the missionaries to borrow foreign words in their biblical translations.

It is true that the objectors, though partially silenced by such authorities, are not altogether convinced. There is still an objection occasionally urged, founded not on fact but on an error in reasoning.

* From a letter of Professor Max Müller to the writer, quoted in "The Iroquois Book of Rites" (1883), vol. ii of Brinton's "Library of Aboriginal American Literature."

The Iroquois, Algonkins, and Mpongwes, we are reminded, are barbarous peoples, and can only have barbarous languages ; which is about as philosophical as it would be to affirm that barbarous tribes must necessarily have barbarous complexions, barbarous hair, and barbarous lungs. Careful comparison of all the known facts will show that the structure and capabilities of a language depend entirely on the natural capacity of the people with whom it originated, and not at all upon their degree of culture. Are we to forget that our own Teutonic and Celtic ancestors were barbarians?

Another difficulty, and perhaps the greatest which has stood in the way of the linguistic classification, has been that which has arisen from the mixture of races. The negroes of the Southern States and of the West Indies speak not African, but Indo-European languages. Berbers in North Africa speak Arabic. Iberians in Spain speak a Latin tongue. Black and woolly-haired tribes in Melanesia speak Malaisian dialects. Throughout the globe these transfusions and comminglings of language and race have been going on for ages. How, then, can we employ as a means of distinction an element, like the linguistic, which is continually varying?

The answer to this objection is plain and conclusive. It is precisely the same answer that a chemist (to revert to our former comparison) would give to a similar objection. "How can your pretended elements," he might be asked, "be made the foundation of a science, when they are constantly occurring in new combinations and strange forms, where they can not be recognized? Your oxygen and hydrogen gases, put together, become a liquid in which no quality of either can be traced. Your carbon is at one time a diamond, and at another time a coal. Do you really mean to offer these constantly-varying substances as the first elements and bases of a science?" "Certainly I do," he would reply ; "and it is in these very combinations and changes of form that a careful analysis has found the clearest evidences and the true value of our science."

Such is exactly the answer of the ethnologist. Analyze carefully the dialects, nominally English, French, or Spanish, which are spoken by the negro populations of America, and we find in them the best possible evidence of the origin of the people who speak them. We find the European words presented in a corrupt state, broken, distorted, often hardly recognizable, the pronunciation strange, the grammar peculiar. Looking still more carefully, we find many words of African origin scattered through the speech. If history were silent, these facts alone would satisfy us that there is here a combination of languages, of which we could detect the various origins. A further experience would show us that in every such case, where a mixture of language exists, there has been invariably a mixture of blood. Whenever a negro or Indian community speaks a dialect which is mainly English or French or Spanish, we may be certain that there is in that community a considerable infusion of English or French or Spanish blood. And though, in such a mingling, the blood of one race and the language of another may preponderate, yet even this fact is not perplexing. Apart from history, the speech alone, rightly studied, will indicate with sufficient clearness the origin and the circumstances of the mixture.*

A striking and indeed crucial test of the decisive value of language in ethnological classification is found in the case of Madagascar. In seeking the origin of its inhabitants we should naturally turn first to Africa; and there, in fact, we find, among the Nubians and the Hamitic tribes of the eastern coast, people bearing sufficient resemblance in shape, features, complexion, and hair, to the natives of Madagascar, to warrant the opinion of their relationship, in the absence of any stronger evidence to the contrary. Remembering, however, that the Arabians in early times had much intercourse with the great African island, we turn to their country and find in the tribes of Yemen a similar resemblance. We then, perhaps, consider how readily the swarthy and curly-haired Dravidians of Southern Hindostan might have found their way to Madagascar, with the help of the northeast monsoon. To decide from which of these probable sources the ancestors of the Madagascar natives were derived, we have recourse to their language; and we ascertain, beyond the shadow of a doubt, that they were neither Africans nor Arabians nor Dravidians, but Malays. To reach their new abode they had to cross the entire width of the Indian Ocean, a distance of three thousand miles. This origin is a fact which no ethnologist now thinks of questioning; and the only decisive evidence to establish it is the language of the islanders. It is true, that when we have ascertained this fact by the linguistic evidence, we find ample material in the character and customs of the people to confirm it; but without the positive test of language this subsidiary evidence would be altogether insufficient as proof of such derivation. No one who considers the case of Madagascar can reasonably doubt that in language, and language only, resides the true distinction of races.

From the great number and the marked peculiarities of the linguistic stocks of this continent, America may be considered to offer by far the best field for the study of scientific ethnology. This fact was early apparent to that remarkable group of philologists, among whom

* Against this comparison of the linguistic stocks with the chemical elements (which is offered, of course, merely as an illustration, and not as an exact parallel), it may be objected that, according to the latest theory, these elements are all merely allotropic forms of a single substance. But, in fact, if the truth of this theory should be established, it will only serve to make the force of the illustration still more striking. In a "vice-presidential address," on the "Origin of Languages," delivered before the section of Anthropology in the American Association for the Advancement of Science (and published in the "Proceedings" of the Association for 1886), I endeavored to show in what manner all the linguistic stocks have probably originated from a single primitive language. Both theories, it may be added, simply exemplify the tendency of science to trace back all varieties to unity.

Duponceau, Gallatin, and Pickering were the most conspicuous, who fifty years ago laid the foundation of American ethnology, basing it entirely on language. Albert Gallatin, applying to the study of linguistics the penetrating sagacity which had resolved the most intricate questions of national diplomacy and finance, framed on this basis his great work, the "Synopsis of the Indian Tribes east of the Rocky Mountains," which, published in 1836, still remains the highest authority on the subject. Later investigators have followed in the same line. Hayden, in his "Ethnography and Philology of the Indian Tribes of the Missouri Valley"; Dall, in his treatises on the "Tribes of Alaska and of Washington Territory"; Powers, in his "Tribes of California"; Stoll, in his "Ethnography of Guatemala"; and Gatschet, in his account of the "Southern Families of Indians," have all been inevitably led to the linguistic classification as the only scientific method. The greatest of living historians has given to this method the weight of his authority. The latest revision of Bancroft's "History of the United States" (1887) comprises a succinct but minutely accurate enumeration of the Indian tribes east of the Mississippi. He finds that there is "no method of grouping them into families but by their languages"; and he has accordingly named and classed the various groups according to their linguistic relations, as fixed by the best authorities. But the profoundest scholar can not be complete in all specialties. It did not occur to the illustrious historian that the distinction of language was significant of a similar distinction in character and customs; and thus, in his subsequent general description of the Indians, he has, like many other writers, been induced to ascribe to them common usages and traits to a greater extent than the facts will fairly warrant. It is true that similar surroundings, together with close intercourse continued for ages, had made a certain superficial resemblance among the various groups of American aborigines within the earlier limits of the United States; but more careful inquiry discloses the radical unlikeness, as decided in many other characteristics as in language. It was inevitable that a special acquaintance with the tribes of the far-extended Algonkin family, with which the English colonists were first and longest in contact, should have colored all their ideas of the Indians. Thus the native habitation which Bancroft describes with his usual graphic clearness—but ascribing it to all the tribes—was simply the slight and temporary shelter of the restless Algonkin rovers. "With long poles fixed in the ground, and bent toward each other at the top, covered with birch or chestnut bark, and hung on the inside with embroidered mats, having no door but a loose skin, no hearth but the ground, no chimney but an opening in the roof, the wigwam was quickly constructed and as easily removed." Widely unlike this flimsy Algonkin tent was the permanent "long-house" of the Huron-Iroquois towns—a regularly-framed dwelling, having firm sidewalls and raftered roof, and sometimes extended to the length of a hundred feet, the capacious habitation of many families. Utterly unlike both of these was the original dwelling of the Dakota race, as seen among the Mandans and Minnetarees, a spacious semicircular structure, partly sunk in the ground, strongly framed and roofed with timber, and covered thickly with earth.

In their religious beliefs the Indians of the several stocks differed as widely from one another as the Arabs differ from the Hindoos, or the Malays from the Japanese. The principal divinity of the Algonkin tribes, known under various names, *Glooskap* among the Penobscots and Micmacs of the far east, *Nanabush* and *Manabosho* among the Delawares and Ojibways, *Napiu* (the Old One) among the Blackfeet of the Northwestern plains, is everywhere the same, and is certainly one of the strangest creations of any mythology—a sort of Jupiter-Scapin, half god and half buffoon, who could only have originated among a people in whom the sense of mirthfulness was stronger than the spirit of reverence. Of a totally different character is the grand tutelary deity of the grave Huron-Iroquois people, known as *Taronhiawagon* (Holder of the Heavens), or *Rawenniyo* (our Great Master)—a deity nobler in character and attributes than any of the Aryan divinities. Singularly unlike both the Algonkin and the Iroquois mythologies is that of the fanciful and intensely religious Dakotas, as we find it described in the excellent work of the Rev. S. R. Riggs, "The Bible among the Dakotas." No more remarkable set of deities, and no more surprising contrast to those of their nearest neighbors, the light-hearted Ojibways, could well be imagined than these extraordinary beings—the *Oon-ktay-he*, or gods of "vital energy"; the *Takoo-shkan-shkan*, or "moving god," who is "too subtile to be perceived by the senses," who "is everywhere present," who "exerts a controlling influence over instinct, intellect, and passion"; and the *Ha-yo-ka*, or "anti-natural god," with whom all things work by the rule of contrary—to whom joy seems grief, and misery brings joy—who shivers in summer and swelters in winter—to whom good is evil, and evil is good. Equally evident to any close observer, but too numerous to be now described, are the wide differences in modes of government, in social systems, and in domestic habits among the Indian communities belonging to the different stocks. Finally—or perhaps it should be said, primarily—each stock has its own psychology, or special traits of intellect and character, of which language, religion, government, and social usages are the natural and necessary manifestations.

We conclude, then, that the true elements and bases of ethnological science are found in linguistic stocks. The number of these is not yet fully ascertained, but is probably not less than three hundred, of which the greater portion belong to the Western Hemisphere. The origin of these stocks is a much-disputed question; but every theory which has been proposed respecting it recognizes the fact that the tribe or people who first spoke the mother-tongue of each stock must have had a common origin, and must have been for a considerable time isolated from all other tribes. During this long period of early isolation, not only was a language formed distinct in vocabulary and grammar from all others, but a peculiar mental and moral character was developed. Each stock had also its special religion, a fact, in America, now recognized by the most experienced observers. Of course, there has been a great mixture of religions, as there has been a great mixture of languages. Most of the Aryan nations, outside of Hindostan, have adopted some form of the Semitic religion; and most of the Dravidian tribes in the south of India have adopted an Aryan religion; but these changes do not prevent us from recognizing the fact that the Aryan, Semitic, and Dravidian religions were originally distinct.

Language, character, and religion do not alone distinguish an original stock. While these characteristics were forming, others not less important were developed. In each stock there was a peculiar social organization, suited to the character and circumstances of the people. Each stock had its own frame of society and government, its own modes of life, and its own industrial and decorative arts. It will, of course, be understood that along with the differences arising from this separate origin there would be resemblances, springing from similarity of circumstances and from the common principles of the human character and intellect. This truth has been well expressed by Professor Putnam, in his recent essay on "Conventionalism in Ancient American Art." "There is now," he remarks, "sufficient evidence to show that the artistic powers of man, like the languages, were developed in distinct centers, from primitive forms of expression, which had necessarily principles in common." We know, also, that arts and institutions are much more readily adopted from other communities than languages; but skilled and scientific observers, like Putnam, Brinton, Mason, Cushing, Dall, Boas, and the many other able investigators who, on our continent, are now engaged in this research, will usually be able to detect these transferences, and to trace back each invention to its peculiar center.

The assertion which is often made, that language is more variable than physical traits, does not stand the test of facts. Language varies little, if at all, through the influences of climate, while physical characteristics—color, hair, stature, and the like—vary widely and rapidly from this cause. The Aryan languages, from Hindostan to Iceland, are radically the same; but the physical differences in the people who speak them are very great. It may be said that these differences are due to minglings with other races, which to a certain extent is doubtless true; but the striking and significant fact remains that the complexion varies throughout very closely in accordance with the climate. The physical differences among the widely-scattered tribes of the Malayo-Polynesian family, from Madagascar to Hawaii, are far more strongly marked than the differences in their dialects. In Africa, the tribes of the Hamitic family, speaking allied languages, vary notably with the climate. The Gallas and Somalis, near the equator, have dark-brown skins and frizzly hair, while their kindred, the Berbers of North Africa, have, in the plains, olive complexions and wavy brown or black hair—and in the mountain valleys, where the climate reminds one of Germany, often display fair skins and reddish or blonde hair, which take our thoughts back to the same country. Here, too, admixtures of negro, Vandal, and other races have been needlessly suggested, to account for facts which the differences of climate sufficiently explain.

But we have examples before our eyes. The differences which have been caused solely by climate, in two or three centuries, between Anglo-Americans and Englishmen, and between Spanish-Americans and Spaniards, are certainly much greater than the differences of language. In Australia, while the language remains unaltered, two generations have sufficed to give rise to a distinct variety of the English "breed of men." It is somewhat surprising that with these examples in full view, and with the many like instances which have been accumulated by Pritchard, Darwin, Quatrefages, and other writers—and in face, too, of the well-known facts that the Semitic, the Chinese, and the Aryan tongues have remained radically unaltered for thousands of years—the delusive notion should still be entertained that physical traits are more permanent than language.

Those who deny the necessary connection of race and language argue that an individual can not change the physical traits which show his origin, while he can, and often does, change his language. But it should be remembered that an individual never thus adopts a new language unless when residing among the people who speak it, and among whom, if he remains and has descendants, these must become intermingled and absorbed. In like manner a community, as has been shown, never adopts a new language except under the direct pressure of a stronger population, with which it ultimately becomes united in one people of mixed blood. If, in this mingled race, one element is much stronger than the other, the weaker element is finally absorbed, leaving perhaps little or no apparent trace, either in the language or the aspect of the population. If both elements are strong, the aspect of the people and the form of the language alike show evidence of the mixture. The fact, therefore, remains that language is the indication, and the only sure indication, of the origin of a community.

But how, then, it may be asked, are we to determine the position of those prehistoric populations, of whom such remarkable traces have been brought to light—the "river-drift men," the "cave men," the lake-dwellers, the mound-builders, the cliff-dwellers—whose languages are utterly unknown? The answer is, that this is a matter which belongs solely to anthropology, and in no manner to ethnology. Much can be learned, of the highest interest and importance, about the men of these vanished tribes—their form and stature, their arts, their mental capacity, their state of civilization; but the races, ethnologically speaking, to which they belonged, can not be ascertained, except by other data than those which we now possess. Whether they were Aryan, Iberian, Uralian, Semitic, Eskimo, Algonkin, Dakotan, Zuñi, Navajo, or whether they belonged, as Prof. Boyd Dawkins supposes of the river-drift men, to a race now utterly extinct, will never be known, unless, as in the case of the Assyrian mounds, some relics are discovered from which their speech can be ascertained. Until this is learned, their affiliations of race will be merely matter of conjecture; and conjecture is not science. As soon as the language is determined, the race will be known. The instant assent which every ethnologist will give to this assertion proves at once, without need of further argument, the truth of the proposition that language is the sole test of race. As the proper deductions from the foregoing facts and arguments, the following propositions are presented for the consideration of anthropologists:

1. The only sure and scientific method of grouping the tribes of men, to show their descent and affiliations, is by the evidence of language. The grouping of men by their languages constitutes the science of ethnology.

2. Ethnologically speaking, the terms "race" and "linguistic stock" are synonymous. The people of each linguistic stock, in their original and unmixed condition, are distinguished from those of other stocks by various peculiarities of physical traits and character, as well as of religion, customs, and arts. The physical differences may, in certain cases, be comparatively slight, as among the American aborigines, and the stocks of Central Africa; but to a practiced eye they are always apparent. When the differences in this respect between two stocks are slight, the inference is simply that, since those stocks originated, the climatic and other influences which affect the physical type have been nearly the same for both.

3. Whenever a mixture of races is indicated in any community by peculiarities of physical traits which can not be ascribed to climate or other natural causes, the language, on a careful analysis, will always show traces of a corresponding mixture; and, on the other hand, a mixture of languages belonging to different linguistic stocks is an invariable indication of a mixture of blood.

To sum up briefly our conclusions, a scientific treatise on ethnology will commence, like a treatise on chemistry, with the primary elements, which, as has been said, are the linguistic stocks. It will determine, as far as possible, the mother-tongue and the original geographical center of each stock. It will describe the moral and intellectual traits and the physical characteristics of the people. It will ascertain their mythology, their social system, their industries, and arts. It will trace their migrations, their interminglings with other septs, and the moral and physical changes caused by these wanderings and mixtures, and by climate, soil, food, manner of life, and all other influences. And finally, from ascertaining what has been, it will seek to determine what is to come, and to show us something of the future which the human species, in its various divisions, may expect to attain.

And this brings us to the important question of the practical value of the science. However highly we may think of the pursuit of knowledge for its own sake, the common judgment of mankind will require that every science which claims its attention and regard shall justify the claim by results, or, in the Baconian phrase, by its "fruit." What, then, have been the fruits of this science of what may be termed "linguistic ethnology," even in its present condition of imperfect development? We may take two notable examples: the one of the benefit it has yielded, the other of the penalty which has followed its neglect.

When the people of Hindostan, in the last century, came under the British power, they were regarded as a debased and alien race. Their complexion reminded their conquerors of Africa. Their divinities were hideous monsters. Their social system was anti-human and detestable. Suttee, thuggee, Juggernaut, all sorts of cruel and shocking abominations, seemed to characterize and degrade them. The proudest Indian prince was, in the sight and ordinary speech of the rawest white subaltern, only a "nigger." This universal contempt was retorted with a hatred as universal, and threatening in the future most disastrous consequences to the British rule. Then came an unexpected and wonderful discovery. European philologists, studying the language of the conquered race, discovered that the classic mother-tongue of Northern Hindostan was the elder sister of the Greek, the Latin, the German, and the Celtic languages. At the same time a splendid literature was unearthed, which filled the scholars of Europe with astonishment and delight. The despised Asiatics became not only the blood-relations, but the teachers and exemplars, of their conquerors. The revulsion of feeling on both sides was immense. Mutual esteem and confidence, to a large extent, took the place of repulsion and distrust. Even in the mutiny which occurred while the change was yet in progress, a very large proportion of the native princes and people refused to take part in the outbreak. Since that time the good-will has steadily grown with the fellowship of common studies and aims. It may fairly be affirmed, at this day, that the discovery of the Sanskrit language and literature has been of more value to England, in the retention and increase of her Indian Empire, than an army of a hundred thousand men.

In an opposite quarter the teachings of ethnology have been unhappily misunderstood and disregarded. The Celtic language is known to be, in the main, an Aryan speech, one of the sisters, as has just been said, of the Sanskrit, the Greek, and the German. But politicians have failed to heed the warning which philologists have given them, that the Celts themselves are a mixed race. Their language bears evidence of this fact, as clearly as the speech of Hispaniola. The broken and distorted vocables, the imperfect and irregular grammar, with many non-Aryan words, show plainly enough that an allophylian people have here adopted the tongue of Aryan intruders, with whom they have amalgamated. This aboriginal people, according to all the evidence we possess, was of Iberian blood; and what the Iberians were we know very well, from their history in Northern Spain and Southern France. Of all the European communities they have displayed the spirit of independence in the strongest degree. Their attachment to their "*fueros*," or communal rights, has been a steady and unquenchable flame. Under the most absolute of the Spanish sovereigns, their right of self-government was usually respected. Any infringement of it awoke indignation, which, if it smoldered for a time, was sure in the end to break out in a fury of rebellion. Such were the people whose national traits form the groundwork of the Celtic character, more especially in Ireland, where the aboriginal tribes were the strongest. A wise statesmanship, dealing with such a people, would, above all things, have sought to gratify their passion for local self-government and for personal independence. How utterly this sentiment has been disregarded, and with what deplorable consequences, the world knows too well.

It would be easy to cite many other examples of the importance of ethnological teachings, shown alike when they are received and when they are rejected. But the ethnology which thus undertakes to teach must be the genuine science, which is based on the only sure foundation—that of language. Anything else which may style itself ethnology is a mere collection of empirical facts, leading to no assured conclusions—and, however entertaining and instructive in some rerespects, is not really entitled to the name of a science. The true ethnology, on the other hand, is a genuine science of the highest value. Every educated man should be familiar with its principles and their application. It is indispensable alike to the historian who would trace the past of a nation, and to the politician who in any capacity aspires to direct its future.

THE official report of the operation of the Cruelty to Animals Act gives the number of experiments made upon living animals last year in Great Britain as 1,035. The use of anæsthetics was dispensed with in 458 cases not painful enough to require it; 213 cases were subject to the condition that the animal should be killed before recovering consciousness; and forty operations were painful in their character, while the amount of pain actually inflicted was nevertheless small. Fifty-four of the sixty-four persons holding licenses performed operations. The "Lancet" sees in this return evidence that on the whole the demands of science were reconciled with the infliction of a very small total of pain and inconvenience upon its victims; and it remarks that, when our business and sports come to be conducted with equal consideration for the brute interests involved, we shall be able to congratulate ourselves on having deserved well indeed of the brute creation.

SCIENCE AND THE BISHOPS.

By Professor T. H. HUXLEY, F. R. S.

IF there is any truth in the old adage that a burned child dreads the fire, I ought to be very loath to touch a sermon while the memory of what befell me on a recent occasion, possibly not yet forgotten by the readers of this Review, is uneffaced. But I suppose that even the distinguished censor of that unheard-of audacity to which not even the newspaper report of a sermon is sacred, can hardly regard a man of science as either indelicate or presumptuous, if he ventures to offer some comments upon three discourses, specially addressed to the great assemblage of men of science which recently gathered at Manchester, by three bishops of the State Church. On my return to England not long ago, I found a pamphlet,* containing a version, which I presume to be authorized, of these sermons, among the huge mass of letters and papers which had accumulated during two months' absence; and I have read them not only with attentive interest, but with a feeling of satisfaction which is quite new to me as a result of hearing or reading sermons. These excellent discourses, in fact, appear to me to signalize a new departure in the course adopted by theology toward science, and to indicate the possibility of bringing about an honorable *modus vivendi* between the two. How far the three bishops speak as accredited representatives of the Church is a question to be considered by-and-by. Most assuredly, I am not authorized to represent any one but myself. But I suppose that there must be a good many people in the Church of the bishops' way of thinking; and I have reason to believe that in the ranks of science there are a good many persons who, more or less, share my views. And it is to these sensible people on both sides, as the bishops and I must needs think those who agree with us, that my present observations are addressed. They will probably be astonished to learn how insignificant, in principle, their differences are.

It is impossible to read the discourses of the three prelates without being impressed by the knowledge which they display, and by the spirit of equity, I might say of generosity, toward science which pervades them. There is no trace of that tacit or open assumption that the rejection of theological dogmas, on scientific grounds, is due to moral perversity, which is the ordinary note of ecclesiastical homilies on this subject, and which makes them look so supremely silly to men whose lives have been spent in wrestling with these questions. There is no attempt to hide away real stumbling-blocks under rhetorical stucco; no resort to

* "The Advance of Science." Three sermons preached in Manchester Cathedral on Sunday, September 4, 1887, during the meeting of the British Association for the Advancement of Science, by the Bishop of Carlisle, the Bishop of Bedford, and the Bishop of Manchester.

the *tu quoque* device of setting scientific blunders against theological errors ; no suggestion that an honest man may keep contradictory beliefs in separate pockets of his brain ; no question that the method of scientific investigation is valid, whatever the results to which it may lead ; and that the search after truth, and truth only, ennobles the searcher and leaves no doubt that his life, at any rate, is worth living. The Bishop of Carlisle declares himself pledged to the belief that "the advancement of science, the progress of human knowledge, is in itself a worthy aim of the greatest effort of the greatest minds."

How often was it my fate, a quarter of a century ago, to see the whole artillery of the pulpit brought to bear upon the doctrine of evolution and its supporters ! Any one unaccustomed to the amenities of ecclesiastical controversy would have thought we were too wicked to be permitted to live. But let us hear the Bishop of Bedford. After a perfectly frank statement of the doctrine of evolution and some of its obvious consequences, that learned prelate pleads, with all earnestness, against

> a hasty denunciation of what *may* be proved to have at least some elements of truth in it, a contemptuous rejection of theories which we *may* some day learn to accept as freely and with as little sense of inconsistency with God's word as we now accept the theory of the earth's motion round the sun, or the long duration of the geological epochs (p. 28).

I do not see that the most convinced evolutionist could ask any one, whether cleric or layman, to say more than this ; in fact, I do not think that any one has a right to say more with respect to any question about which two opinions can be held, than that his mind is perfectly open to the force of evidence.

There is another portion of the Bishop of Bedford's sermon which I think will be warmly appreciated by all honest and clear-headed men. He repudiates the views of those who say that theology and science

> occupy wholly different spheres, and need in no way intermeddle with each other. They revolve, as it were, in different planes, and so never meet. Thus we may pursue scientific studies with the utmost freedom, and, at the same time, may pay the most reverent regard to theology, having no fears of collision, because allowing no points of contact (p. 29).

Surely every unsophisticated mind will heartily concur with the bishop's remark upon this convenient refuge for the descendants of Mr. Facing-both-ways. "I have never been able to understand this position, though I have often seen it assumed." Nor can any demurrer be sustained when the bishop proceeds to point out that there are, and must be, various points of contact between theological and natural science, and therefore that it is foolish to ignore or deny the existence of as many dangers of collision.

Finally, the Bishop of Manchester freely admits the force of the objections which have been raised, on scientific grounds, to prayer, and attempts to turn them by arguing that the proper objects of prayer are not physical but spiritual. He tells us that natural accidents and moral misfortunes are not to be taken for moral judgments of God; he admits the propriety of the application of scientific methods to the investigation of the origin and growth of religions; and he is as ready to recognize the process of evolution there as in the physical world. Mark the following striking passage:

> And how utterly all the common objections to Divine revelation vanish away when they are set in the light of this theory of a spiritual progression. Are we reminded that there prevailed, in those earlier days, views of the nature of God and man, of human life and Divine Providence, which we now find to be untenable? *That*, we answer, is precisely what the theory of development presupposes. If early views of religion and morality had not been imperfect, where had been the development? If symbolical visions and mythical creations had found no place in the early Oriental expression of Divine truth, where had been the development? The sufficient answer to ninety-nine out of a hundred of the ordinary objections to the Bible, as the record of a Divine education of our race, is asked in that one word—development. And to what are we indebted for that potent word, which, as with the wand of a magician, has at the same moment so completely transformed our knowledge and dispelled our difficulties? To modern science, resolutely pursuing its search for truth in spite of popular obloquy, and—alas! that one should have to say it—in spite too often of theological denunciation (p. 53).

Apart from its general importance, I read this remarkable statement with the more pleasure, since, however imperfectly I may have endeavored to illustrate the evolution of theology in a paper published in this Review last year, it seems to me that in principle, at any rate, I may hereafter claim high theological sanction for the views there set forth.

If theologians are henceforward prepared to recognize the authority of secular science in the manner and to the extent indicated in the Manchester trilogy; if the distinguished prelates who offer these terms are really plenipotentiaries, then, so far as I may presume to speak on such a matter, there will be no difficulty about concluding a perpetual treaty of peace, and indeed of alliance, between the high contracting powers, whose history has hitherto been little more than a record of continual warfare. But if the great chancellor's maxim, "Do ut des," is to form the basis of negotiation, I am afraid that secular science will be ruined; for it seems to me that theology, under the generous impulse of a sudden conversion, has given all that she hath; and indeed, on one point, has surrendered more than can reasonably be asked.

I suppose I must be prepared to face the reproach which attaches to those who criticise a gift, if I venture to observe that I do not think that the Bishop of Manchester need have been so much alarmed as he evidently has been, by the objections which have often been raised to prayer, on the ground that a belief in the efficacy of prayer is inconsistent with a belief in the constancy of the order of Nature.

The bishop appears to admit that there is an antagonism between the "regular economy of Nature" and the "regular economy of prayer" (p. 39), and that "prayers for the interruption of God's natural order" are of "doubtful validity" (p. 42). It appears to me that the bishop's difficulty simply adds another example to those which I have several times insisted upon in the pages of this Review and elsewhere, of the mischief which has been done, and is being done, by a mistaken apprehension of the real meaning of "natural order" and "law of Nature."

May I, therefore, be permitted to repeat, once more, that the statements denoted by these terms have no greater value or cogency than such as may attach to generalizations from experience of the past, and to expectations for the future based upon that experience? Nobody can presume to say what the order of Nature must be; all that the widest experience (even if it extended over all past time and through all space), that events had happened in a certain way could justify, would be a proportionally strong expectation that events will go on so happening, and the demand for a proportional strength of evidence in favor of any assertion that they had happened otherwise.

It is this weighty consideration, the truth of which every one who is capable of logical thought must surely admit, which knocks the bottom out of all *a priori* objections either to ordinary "miracles" or to the efficacy of prayer, in so far as the latter implies the miraculous intervention of a higher power. No one is entitled to say *a priori* that any given so-called miraculous event is impossible; and no one is entitled to say *a priori* that prayer for some change in the ordinary course of Nature can not possibly avail.

The supposition that there is any inconsistency between the acceptance of the constancy of natural order and a belief in the efficacy of prayer, is the more unaccountable as it is obviously contradicted by analogies furnished by everyday experience. The belief in the efficacy of prayer depends upon the assumption that there is somebody, somewhere, who is strong enough to deal with the earth and its contents as men deal with the things and events which they are strong enough to modify or control; and who is capable of being moved by appeals such as men make to one another. This belief does not even involve theism; for our earth is an insignificant particle of the solar system, while the solar system is hardly worth speaking of in relation to the All; and, for anything that can be proved to the contrary, there may be beings endowed with full powers over our system, yet, practically, as insignificant as ourselves in relation to the universe. If any one pleases, therefore, to give unrestrained liberty to his fancy, he may plead analogy in favor of the dream that there may be, somewhere, a finite being, or beings, who can play with the solar system as a child plays with a toy; and that such being may be willing to do anything which he is properly supplicated to do, For we are not justified in saying that it is impossible for beings having the nature of men, only vastly more powerful, to exist; and if they do exist, they may act as and when we ask them to do so, just as our brother men act. As a matter of fact, the great mass of the human race has believed, and still believes, in such beings, under the various names of fairies, gnomes, angels, and demons. Certainly I do not lack faith in the constancy of natural order. But I am not less convinced that if I were to ask the Bishop of Manchester to do me a kindness which lay within his power, he would do it. And I am unable to see that his action on my request involves any violation of the order of Nature. On the contrary, as I have not the honor to know the bishop personally, my action would be based upon my faith in that "law of Nature," or generalization from experience, which tells me that, as a rule, men who occupy the bishop's position are kindly and courteous. How is the case altered if my request is preferred to some imaginary superior being, or to the Most High Being, who, by the supposition, is able to arrest disease, or make the sun stand still in the heavens, just as easily as I can stop my watch, or make it indicate any hour that pleases me?

I repeat that it is not upon any *a priori* considerations that objections, either to the supposed efficacy of prayer in modifying the course of events, or to the supposed occurrence of miracles, can be scientifically based. The real objection, and, to my mind, the fatal objection, to both these suppositions, is the inadequacy of the evidence to prove any given case of such occurrences which has been adduced. It is a canon of common sense, to say nothing of science, that the more improbable a supposed occurrence, the more cogent ought to be the evidence in its favor. I have looked somewhat carefully into the subject, and I am unable to find in the records of any miraculous event evidence which even approximates to the fulfilment of this requirement.

But, in the case of prayer, the bishop points out a most just and necessary distinction between its effect on the course of Nature outside ourselves and its effect within the region of the supplicator's mind.

It is a "law of Nature," verifiable by everyday experience, that our already-formed convictions, our strong desires, our intent occupation with particular ideas, modify our mental operations to a most marvelous extent, and produce enduring changes in the direction and in the intensity of our intellectual and moral activities.

Men can intoxicate themselves with ideas as effectually as with alcohol or with bang, and produce, by dint of intense thinking, mental conditions hardly distinguishable from monomania. Demoniac possession is mythical; but the faculty of being possessed, more or less completely, by an idea is probably the fundamental condition of what is called genius, whether it show itself in the saint, the artist, or the man of science. One calls it faith, another calls it inspiration, a third calls it insight; but the "intending of the mind," to borrow Newton's well-known phrase, the concentration of all the rays of intellectual energy on some one point, until it glows and colors the whole cast of thought with its peculiar light, is common to all.

I take it that the Bishop of Manchester has psychological science with him when he insists upon the subjective efficacy of prayer in faith, and on the seemingly miraculous effects which such intending of the mind upon religious and moral ideals may have upon character and happiness. Scientific faith, at present, takes it no further than the prayer which Ajax offered; but that petition is continually granted.

Whatever points of detail may yet remain open for discussion, however, I repeat the opinion I have already expressed that the Manchester sermons concede all that science has an indisputable right, or any pressing need, to ask, and that not grudgingly but generously; and, if the three bishops of 1887 carry the Church with them, I think they will have as good title to the permanent gratitude of posterity as the famous seven who went to the Tower in defense of the Church two hundred years ago.

Will their brethren follow their just and prudent guidance? I have no such acquaintance with the currents of ecclesiastical opinion as would justify me in even hazarding a guess on such a difficult topic. But some recent omens are hardly favorable. There seems to be an impression abroad—I do not desire to give any countenance to it—that I am fond of reading sermons. From time to time, unknown correspondents—some apparently animated by the charitable desire to promote my conversion, and others unmistakably anxious to spur me to the expression of wrathful antagonism—favor me with reports or copies of such productions.

I found one of the latter category among the accumulated arrears to which I have already referred.

It is a full, and apparently accurate, report of a discourse by a person of no less ecclesiastical rank than the three authors of the sermons I have hitherto been considering; but who he is, and where or when the sermon was preached, are secrets which wild horses shall not tear from me, lest I fall again under high censure for attacking a clergyman. Only if the editor of this Review thinks it his duty to have independent evidence that the sermon has a real existence, will I, in the strictest confidence, communicate it to him.

The preacher, in this case, is of a very different mind from the three bishops—and this mind is different in quality, different in spirit, and different in contents. He discourses on the *a priori* objections to miracles, apparently without being aware, in spite of all the discussions of the last seven or eight years, that he is doing battle with a shadow.

I trust I do not misrepresent the Bishop of Manchester in saying that the essence of his remarkable discourse is the insistence upon the "supreme importance of the purely spiritual in our faith," and of the relative, if not absolute, insignificance of aught else. He obviously perceives the bearing of his arguments against the alterability of the course of outward Nature by prayer, on the question of miracles in general; for he is careful to say that "the possibility of miracles, of a rare and unusual transcendence of the world order, is not here in question" (p. 38). It may be permitted me to suppose, however, that, if miracles were in question, the speaker who warns us "that we must look for the heart of the absolute religion in that part of it which prescribes our moral and religious relations" (p. 46), would not be disposed to advise those who had found the heart of Christianity to take much thought about its miraculous integument.

My anonymous sermon will have nothing to do with such notions as these, and its preacher is not too polite, to say nothing of charitable, toward those who entertain them.

> Scientific men, therefore, are perfectly right in asserting that Christianity rests on miracles. If miracles never happened, Christianity, in any sense which is not a mockery, which does not make the term of none effect, has no reality. I dwell on this because there is now an effort making to get up a non-miraculous, invertebrate Christianity, which may escape the ban of science. And I would warn you very distinctly against this new contrivance. Christianity is essentially miraculous, and falls to the ground if miracles be impossible.

Well, warning for warning. I venture to warn this preacher and those who, with him, persist in identifying Christianity with the miraculous, that such forms of Christianity are not only doomed to fall to the ground, but that, within the last half-century, they have been driving that way with continually accelerated velocity.

The so-called religious world is given to a strange delusion. It fondly imagines that it possesses the monopoly of serious and constant reflection upon the terrible problems of existence; and that those who can not accept its shibboleths are either mere Gallios, caring for none of these things, or libertines desiring to escape from the restraints of morality. It does not appear to have entered the imaginations of these people that outside their pale, and firmly resolved never to enter it, there are thousands of men, certainly not their inferiors in character, capacity, or knowledge of the questions at issue, who estimate those purely spiritual elements of the Christian faith of which the Bishop of Manchester speaks as highly as the bishop does, but who will have nothing to do with the Christian churches, because in their apprehension, and for them, the profession of belief in the miraculous, on the evidence offered, would be simply immoral.

So far as my experience goes, men of science are neither better nor worse than the rest of the world. Occupation with the endlessly great parts of the universe does not necessarily involve greatness of character, nor does microscopic study of the infinitely little always produce humility. We have our full share of original sin; need, greed, and vainglory beset us as they do other mortals; and our progress is, for the most part, like that of a tacking ship, the resultant of opposite divergencies from the straight path. But, for all that, there is one moral benefit which the pursuit of science unquestionably bestows. It keeps the estimate of the value of evidence up to the proper mark; and we are constantly receiving lessons, and sometimes very sharp ones, on the nature of proof. Men of science will always act up to their standard of veracity, when mankind in gereral leave off sinning; but that standard appears to me to be higher among them than in any other class of the community.

I do not know any body of scientific men who could be got to listen without the strongest expressions of disgusted repudiation to the exposition of a pretended scientific discovery, which had no better evidence to show for itself than the story of the devils entering a herd of swine, or of the fig-tree that was blasted for bearing no figs when "it was not the season of figs." Whether such events are possible or impossible, no man can say; but scientific ethics can and does declare that the profession of belief in them, on the evidence of documents of unknown date and of unknown authorship, is immoral. Theological apologists who insist that morality will vanish if their dogmas are exploded, would do well to consider the fact that, in the matter of intellectual veracity, science is already a long way ahead of the churches; and that, in this particular, it is exerting an educational influence on mankind of which the churches have shown themselves utterly incapable.

Undoubtedly that varying compound of some of the best and some of the worst elements of Paganism and Judaism, molded in practice by the innate character of certain people of the Western world, which since the second century has assumed to itself the title of orthodox Christianity, "rests on miracles," and falls to the ground, not "if miracles be impossible," but if those to which it is committed prove themselves unable to fulfill the conditions of honest belief.

That this Christianity is doomed to fall is, to my mind, beyond a doubt; but its fall will be neither sudden nor speedy. The Church, with all the aid lent it by the secular arm, took many centuries to extirpate the open practice of pagan idolatry within its own fold; and those who have traveled in Southern Europe will be aware that it has not extirpated the essence of such idolatry even yet. *Mutato nomine*, it is probable that there is as much sheer fetichism among the Roman populace now as there was eighteen hundred years ago; and if Marcus Antoninus could descend from his horse and ascend the steps of the Ara Cœli church about Twelfth Day, the only thing that need strike him would be the extremely contemptible character of the modern idols as works of art.

Science will certainly neither ask for, nor receive, the aid of the secular arm. It will trust to the much better and more powerful help of that education in scientific truth and in the morals of assent which is rendered as indispensable as it is inevitable by the permeation of practical life with the products and ideas of science. But no one who considers the present state of even the most developed countries can doubt that the scientific light that has come into the world will for a long time have to shine in the midst of darkness. The urban populations, driven into contact with science by trade and manufacture, will more and more receive it, while the *pagani* will lag behind. Let us hope that no Julian may arise among them to head a forlorn hope against the enevitable. Whatever happens, Science may bide her time in patience and in confidence.

But to return to my "Anonymous." I am afraid that if he represents any great party in the Church, the spirit of justice and reasonableness which animates the three bishops has as slender chance of being imitated, on a large scale, as their common sense and their courtesy. For, not contented with misrepresenting science on its speculative side, "Anonymous" attacks its morality.

> For two whole years investigations and conclusions which would upset the theories of Darwin on the formation of coral islands were actually suppressed, and that by the advice even of those who accepted them, *for fear of upsetting the faith and disturbing the judgment formed by the multitude on the scientific character—the infallibility—of the great master!*

So far as I know anything about the matters which are here referred to, the part of this passage which I have italicized is absolutely untrue. I believe that I am intimately acquainted with all Mr. Darwin's immediate scientific friends; and I say that no one of them, nor any other man of science known to me, ever could, or would, have given such advice to any one—if for no other reason than that, with the example of the most candid and patient listener to objections that ever lived, fresh in their memories, they could not so grossly have at once violated their highest duty and dishonored their friend.

The charge thus brought by "Anonymous" affects the honor and the probity of men of science; if it is true, we have forfeited all claim to the confidence of the general public. In my belief it is utterly false, and its real effect will be to discredit those who are responsible for it. As is the way with slanders, it has grown by repetition. "Anonymous" is responsible for the peculiarly offensive form which it has taken in his hands; but he is not responsible for originating it. He has evidently been inspired by an article entitled, "A Great Lesson," published in the September number of this Review.* Truly it is "a great lesson," but not quite in the sense intended by the giver thereof.

* See "The Popular Science Monthly" for December, 1887.

In the course of his doubtless well-meant admonitions, the Duke of Argyll commits himself to a greater number of statements which are demonstrably incorrect, and which any one who ventured to write upon the subject ought to have known to be incorrect, than I have ever seen gathered together in so small a space.

I submit a gathering from the rich store for the appreciation of the public.

First :

> Mr. Murray's new explanation of the structure of coral reefs and islands was communicated to the Royal Society of Edinburgh in 1880, and supported with such a weight of facts and such a close texture of reasoning, that no serious reply has ever been attempted (see "The Popular Science Monthly," p. 252).

"No serious reply has ever been attempted !" I suppose that the Duke of Argyll may have heard of Professor Dana, whose years of labor devoted to corals and coral-reefs when he was naturalist of the American expedition under Commodore Wilkes, more than forty years ago, have ever since caused him to be recognized as an authority of the first rank on such subjects. Now does his Grace know, or does he not know, that, in the year 1885, Professor Dana published an elaborate paper "On the Origin of Coral Reefs and Islands," in which, after referring to a presidential address by the Director of the Geological Survey of Great Britain and Ireland delivered in 1883, in which special attention is directed to Mr. Murray's views, Professor Dana says :

> The existing state of doubt on the question has led the writer to reconsider the earlier and later facts, and in the following pages he gives his results.

Professor Dana then devotes many pages of his very "serious reply" to a most admirable and weighty criticism of the objections which have at various times been raised to Mr. Darwin's doctrine, by Professor Semper, by Dr. Rein, and finally by Mr. Murray, and he states his final judgment as follows :

> With the theory of abrasion and solution incompetent, all the hypotheses of objectors to Darwin's theory are alike weak ; for all have made these processes their chief reliance, whether appealing to a calcareous or a volcanic or a mountain-peak basement for the structure. The subsidence which the Darwinian theory requires has not been opposed by the mention of any fact at variance with it, nor by setting aside Darwin's arguments in its favor ; and it has found new support in the facts from the Challenger's soundings off Tahiti, that had been put in array against it, and strong corroboration in the facts from the West Indies.
>
> Darwin's theory, therefore, remains as the theory that accounts for the origin of reefs and islands.*

Be it understood that I express no opinion on the controverted points. I doubt if there are ten living men who, having a practical

* "American Journal of Science," 1885, p. 190.

knowledge of what a coral reef is, have endeavored to master the very difficult biological and geological problems involved in their study. I happen to have spent the best part of three years among coral reefs and to have made that attempt; and, when Mr. Murray's work appeared, I said to myself that until I had two or three months to give to the renewed study of the subject in all its bearings, I must be content to remain in a condition of suspended judgment. In the meanwhile, the man who would be voted by common acclamation as the most competent person now living to act as umpire, has delivered the verdict I have quoted; and, to go no further, has fully justified the hesitation I and others may have felt about expressing an opinion. Under these circumstances, it seems to me to require a good deal of courage to say "no serious reply has ever been attempted"; and to chide the men of science, in lofty tones, for their "reluctance to admit an error" which is not admitted; and for their "slow and sulky acquiescence" in a conclusion which they have the gravest warranty for suspecting!

Second:

> Darwin himself had lived to hear of the new solution, and, with that splendid candor which was eminent in him, his mind, though now grown old in his own early convictions, was at least ready to entertain it, and to confess that serious doubts had been awakened as to the truth of his famous theory (p. 252).

I wish that Darwin's splendid candor could be conveyed by some description of spiritual "microbe" to those who write about him. I am not aware that Mr. Darwin ever entertained "serious doubts as to the truth of his famous theory"; and there is tolerably good evidence to the contrary. The second edition of his work, published in 1876, proves that he entertained no such doubts then; a letter to Professor Semper, whose objections, in some respects, forestalled those of Mr. Murray, dated October 2, 1879, expresses his continued adherence to the opinion "that the atolls and barrier reefs in the middle of the Pacific and Indian Oceans indicate subsidence"; and the letter of my friend Professor Judd, printed at the end of this article (which I had perhaps better say Professor Judd has not seen) will prove that this opinion remained unaltered to the end of his life.

Third:

> . . . Darwin's theory is a dream. It is not only unsound, but it is in many respects the reverse of truth. With all his conscientiousness, with all his caution, with all his powers of observation, Darwin in this matter fell into errors as profound as the abysses of the Pacific (p. 249).

Really? It seems to me that, under the circumstances, it is pretty clear that these lines exhibit a lack of the qualities justly ascribed to Mr. Darwin, which plunges their author into a much deeper abyss, and one from which there is no hope of emergence.

Fourth :

All the acclamations with which it was received were as the shouts of an ignorant mob (p. 249).

But surely it should be added that the Coryphæus of this ignorant mob, the fugelman of the shouts, was one of the most accomplished naturalists and geologists now living—the American Dana—who, after years of independent study extending over numerous reefs in the Pacific, gave his hearty assent to Darwin's views, and, after all that had been said, deliberately reaffirmed that assent in the year 1885.

Fifth :

The overthrow of Darwin's speculation is only beginning to be known. It has been whispered for some time. The cherished dogma has been dropping very slowly out of sight (p. 249).

Darwin's speculation may be right or wrong, but I submit that that which has not happened can not even begin to be known, except by those who have miraculous gifts to which we poor scientific people do not aspire. The overthrow of Darwin's views may have been whispered by those who hoped for it ; and they were perhaps wise in not raising their voices above a whisper. Incorrect statements, if made too loudly, are apt to bring about unpleasant consequences.

Sixth. Mr. Murray's views, published in 1880, are said to have met with "slow and sulky acquiescence" (p. 252). I have proved that they can not be said to have met with general acquiescence of any sort, whether quick and cheerful, or slow and sulky ; and if this assertion is meant to convey the impression that Mr. Murray's views have been ignored, that there has been a conspiracy of silence against them, it is utterly contrary to notorious fact.

Professor Geikie's well-known "Text-book of Geology" was published in 1882, and at pages 457–9 of that work there is a careful exposition of Mr. Murray's views. Moreover, Professor Geikie has specially advocated them on other occasions,* notably in a long article on "The Origin of Coral Reefs," published in two numbers of "Nature" for 1883, and in a presidential address delivered in the same year. If, in so short a time after the publication of his views, Mr. Murray could boast of a convert so distinguished and influential as the Director of the Geological Survey, it seems to me that this wonderful *conspiration de silence* (which has about as much real existence as the Duke of Argyll's other bogie, "the Reign of Terror") must have *ipso facto* collapsed. I wish that, when I was a young man, my endeavors to upset some prevalent errors had met with as speedy and effectual backing.

Seventh :

. . . Mr. John Murray was strongly advised against the publication of his

* Professor Geikie, however, though a strong, is a fair and candid advocate. He says of Darwin's theory, "That it may be possibly true, in some instances, may be readily granted." For Professor Geikie, then, it is not yet overthrown—still less a dream.

views in derogation of Darwin's long-accepted theory of the coral islands, and was actually induced to delay it for two years. Yet the late Sir Wyville Thomson, who was at the head of the naturalists of the Challenger expedition, was himself convinced by Mr. Murray's reasoning (p. 255).

Clearly, then, it could not be Mr. Murray's official chief who gave him this advice. Who was it? And what was the exact nature of the advice given? Until we have some precise information on this head, I shall take leave to doubt whether this statement is more accurate than those which I have previously cited.

Whether such advice was wise or foolish, just or immoral, depends entirely on the motive of the person who gave it. If he meant to suggest to Mr. Murray that it might be wise for a young and comparatively unknown man to walk warily, when he proposed to attack a generalization based on many years' labor of one undoubtedly competent person, and fortified by the independent results of the many years' labor of another undoubtedly competent person, and even, if necessary, to take two whole years in fortifying his position, I think that such advice would have been sagacious and kind. I suppose that there are few working men of science who have not kept their ideas to themselves, while gathering and sifting evidence, for a much longer period than two years.

If, on the other hand, Mr. Murray was advised to delay the publication of his criticisms, simply to save Mr. Darwin's credit and to preserve some reputation for infallibility, which no one ever heard of, then I have no hesitation in declaring that his advisor was profoundly dishonest, as well as extremely foolish, and that, if he is a man of science, he has disgraced his calling.

But, after all, this supposed scientific Achitophel has not yet made good the primary fact of his existence. Until the needful proof is forthcoming, I think I am justified in suspending my judgment as to whether he is much more than an anti-scientific myth. I leave it to the Duke of Argyll to judge of the extent of the obligation under which, for his own sake, he may lie to produce the evidence on which his aspersions of the honor of scientific men are based. I can not pretend that we are seriously disturbed by charges which every one who is acquainted with the truth of the matter knows to be ridiculous; but mud has a habit of staining if it lies too long, and it is as well to have it brushed off as soon as may be.

So much for the "Great Lesson." It is followed by a "Little Lesson" apparently directed against my infallibility—a doctrine about which I should be inclined to paraphrase Wilkes's remark to George III when he declared that he, at any rate, was not a Wilkite. But I really should be glad to think that there are people who need the warning, because then it will be obvious that this raking up of an old story can not have been suggested by a mere fanatical desire to damage men of science. I can but rejoice, then, that these misguided enthusiasts, whose faith in me has so far exceeded the bounds of reason, should be set right. But that "want of finish" in the matter of accuracy which so terribly mars the effect of the "Great Lesson," is no less conspicuous in the case of the "Little Lesson," and, instead of setting my too fervent disciples right, it will set them wrong.

The Duke of Argyll, in telling the story of *Bathybius*, says that my mind was "caught by this new and grand generalization of the physical basis of life." I never have been guilty of a reclamation about anything to my credit, and I do not mean to be; but if there is any blame going, I do not choose to be relegated to a subordinate place when I have a claim to the first. The responsibility for the first description and the naming of *Bathybius* is mine and mine only. The paper on "Some Organisms living at Great Depths in the Atlantic Ocean," in which I drew attention to this substance, is to be found by the curious in the eighth volume of the "Quarterly Journal of Microscopical Science," and was published in the year 1868. Whatever errors are contained in that paper are my own peculiar property; but neither at the meeting of the British Association in 1868, nor anywhere else, have I gone beyond what is there stated; except in so far that, at a long subsequent meeting of the association, being importuned about the subject, I ventured to express, somewhat emphatically, the wish that the thing was at the bottom of the sea.

What is meant by my being caught by a generalization about the physical basis of life I do not know; still less can I understand the assertion that *Bathybius* was accepted because of its supposed harmony with Darwin's speculations. That which interested me in the matter was the apparent analogy of *Bathybius* with other well-known forms of lower life, such as the plasmodia of the Myxomycetes and the Rhizopods. Speculative hopes or fears had nothing to do with the matter; and if *Bathybius* were brought up alive from the bottom of the Atlantic to-morrow, the fact would not have the slightest bearing, that I can discern, upon Mr. Darwin's speculations, or upon any of the disputed problems of biology. It would merely be one elementary organism the more added to the thousands already known.

Up to this moment I was not aware of the universal favor with which *Bathybius* was received.* Those simulators of an "ignorant mob" who, according to the Duke of Argyll, welcomed Darwin's theory of coral reefs, made no demonstration in my favor, unless his Grace includes Sir Wyville Thomson, Dr. Carpenter, Dr. Bessels, and Professor Haeckel under that head. On the contrary, a sagacious friend of mine, than whom there was no more competent judge, the

* I find, moreover, that I specially warned my readers against hasty judgment. After stating the facts of observation, I add, "I have, hitherto, said nothing about their meaning, as, in an inquiry so difficult and fraught with interest as this, it seems to me to be in the highest degree important to keep the questions of fact and the questions of interpretation well apart."

late Mr. George Busk, was not to be converted; while, long before the Challenger work, Ehrenberg wrote to me very skeptically, and I fully expected that that eminent man would favor me with pretty sharp criticism. Unfortunately, he died shortly afterward, and nothing from him, that I know of, appeared. When Sir Wyville Thomson wrote to me a brief account of the results obtained on board the Challenger, I sent his statement to "Nature," in which journal it appeared the following week, without any further note or comment than was needful to explain the circumstances. In thus allowing judgment to go by default, I am afraid I showed a reckless and ungracious disregard for the feelings of the believers in my infallibility. No doubt I ought to have hedged and fenced and attenuated the effect of Sir Wyville Thomson's brief note in every possible way. Or perhaps I ought to have suppressed the note altogether, on the ground that it was a mere *ex parte* statement. My excuse is that, notwithstanding a large and abiding faith in human folly, I did not know then, any more than I know now, that there was anybody foolish enough to be unaware that the only people, scientific or other, who never make mistakes are those who do nothing; or that anybody, for whose opinion I cared, would not rather see me commit ten blunders than try to hide one.

Pending the production of further evidence, I hold that the existence of people who believe in the infallibility of men of science is as purely mythical as that of the evil counselor who advised the withholding of the truth lest it should conflict with that belief.

I venture to think, then, that the Duke of Argyll might have spared his "Little Lesson" as well as his "Great Lesson" with advantage. The paternal authority who whips the child for sins he has not committed does not strengthen his moral influence—rather excites contempt and repugnance. And if, as would seem from this and former monitory allocutions which have been addressed to us, the duke aspires to the position of censor, or spiritual director, in relation to the men who are doing the work of physical science, he really must get up his facts better. There will be an end to all chance of our kissing the rod if his Grace goes wrong a third time. He must not say again that "no serious reply has been attempted" to a view which was discussed and repudiated two years before by one of the highest extant authorities on the subject; he must not say that Darwin accepted that which it can be proved he did not accept; he must not say that a doctrine has dropped into the abyss when it is quite obviously alive and kicking at the surface; he must not assimilate a man like Professor Dana to the components of an "ignorant mob"; he must not say that things are beginning to be known which are not known at all; he must not say that "slow and sulky acquiescence" has been given to that which can not yet boast of general acquiescence of any kind; he must not suggest that a view which has been publicly advocated by the Director of the Geological Survey and no less publicly discussed by many other authoritative writers has been intentionally and systematically ignored; he must not ascribe ill motives for a course of action which is the only proper one; and, finally, if any one but myself were interested, I should say that he had better not waste his time in raking up the errors of those whose lives have been occupied not in talking about science, but in toiling, sometimes with success and sometimes with failure, to get some real work done.

The most considerable difference I note among men is not in their readiness to fall into error, but in their readiness to acknowledge these inevitable lapses. The Duke of Argyll has now a splendid opportunity for proving to the world in which of these categories it is hereafter to rank him.

DEAR PROFESSOR HUXLEY: A short time before Mr. Darwin's death I had a conversation with him concerning the observations which had been made by Mr. Murray upon coral reefs, and the speculations which had been founded upon those observations. I found that Mr. Darwin had very carefully considered the whole subject, and that while, on the one hand, he did not regard the actual facts recorded by Mr. Murray as absolutely inconsistent with his own theory of subsidence, on the other hand, he did not believe that they necessitated or supported the hypothesis advanced by Mr. Murray. Mr. Darwin's attitude, as I understood it, toward Mr. Murray's objections to the theory of subsidence was exactly similar to that maintained by him with respect to Professor Semper's criticism, which was of a very similar character; and his position with regard to the whole question was almost identical with that subsequently so clearly defined by Professor Dana in his well-known articles published in the "American Journal of Science" for 1885.

It is difficult to imagine how any one, acquainted with the scientific literature of the last seven years, could possibly suggest that Mr. Murray's memoir published in 1880 had failed to secure a due amount of attention. Mr. Murray, by his position in the Challenger office, occupied an exceptionally favorable position for making his views widely known; and he had moreover the singular good fortune to secure from the first the advocacy of so able and brilliant a writer as Professor Archibald Geikie, who in a special discourse and in several treatises on geology and physical geology very strongly supported the new theory. It would be an endless task to attempt to give references to the various scientific journals which have discussed the subject, but I may add that every treatise on geology which has been published since Mr. Murray's views were made known has dealt with his observations at considerable length. This is true of Professor A. H. Green's "Physical Geology" published in 1882; of Professor Prestwich's "Geology, Chemical and Physical"; and of

Professor James Geikie's "Outlines of Geology," published in 1886. Similar prominence is given to the subject in De Lapparent's "Traité de Géologie," published in 1885, and in Credner's "Elemente der Geologie" which has appeared during the present year. If this be a "conspiracy of silence," where, alas! can the geological speculator seek for fame? Yours, very truly, JOHN W. JUDD.

October 10, 1887.

—*Nineteenth Century.*

THE OUTCOME OF THE GRANGER MOVEMENT.

By CHARLES W. PIERSON.

THE founders of the Grange thought they were establishing an order whose aims were to be social and educational. But these were soon overshadowed by the co-operative, anti-middleman feature. This drew more into the order than all other considerations combined, at one time almost threatening to transform our farming population into a race of traders, and this was likewise the chief cause of Grange decay. Fighting middlemen, unlike fighting railroads, was a legitimate kind of activity, as it had nothing to do with politics or theology—the two subjects tabooed by Granger law. Unfortunately, the story of Grange co-operation is recorded nowhere and thoroughly known to nobody. Those who know most preserve a discreet silence, mindful of questionable transactions and failures, now generally forgotten.

No sooner had Kelley established a few Granges in Minnesota in 1869 than they set up a clamor for leasing flouring-mills and appointing agents in St. Paul and New York, in order to mill and ship their own grain. However farcical might be the position of the founders at Washington, they at least were conservative enough to disavow this action. But upon Minnesota's threat to secede they yielded, and an agent was appointed in St. Paul. His first commission chanced to be to buy a jackass for a Patron, whereupon one of the founders made comment: "This purchasing business commenced with buying asses; the prospects are that many will be sold." As soon as the National Grange fell into the hands of farmers, there was a movement to make it the head of a gigantic co-operative scheme. It was proposed to have three national purchasing-agents, stationed at New York, Chicago, and New Orleans, to buy for the Patrons of the whole country. But this was soon seen to be impracticable, owing to the diversity of interests in the order. The same was true with regard to the purchase of patent-rights. With the view of absorbing into the order the profits of manufacturing farming-implements, the National Grange had bought the right to manufacture a harvester, a mower and reaper, and various other machines. It had also tried to buy the copyright of Cushing's "Manual"—a book in great demand among the Grangers. Meanwhile, the Executive Committee was busy in another direction. Congressman Aiken of South Carolina, one of its members, says that they "visited the manufacturers who supplied the market with such implements as the farmers needed, from a scooter-plow to a parlor-organ, proposing to concentrate the purchases of the order where the greatest discounts were obtained for cash. In no instance did they fail to secure a reduction of twenty-five to fifty per cent." Mr. Aiken notes the astonishment of one cutlery-maker at a single order for ten thousand pruning-knives of a particular pattern. Such enormous reductions from regular prices were obtained only under a pledge of secrecy. But as information had to be distributed by thousands of printed sheets, the Patrons could not keep the secret. The contracts leaked out, causing the withdrawal of many firms from their agreements. What experiments the National Grange might have tried with the great sums in its treasury can only be conjectured, as its resources and influence over the subordinate lodges were crippled almost fatally in the Charleston meeting in 1875. It probably would have continued the crop reports, which, though costly, and often unreliable through the ignorance and carelessness of Granges about furnishing statistics, had proved valuable. Like the State Granges, which had full treasuries, it might have squandered its capital and come to grief on co-operative ventures. Such is the inference to be drawn from utterances like the following, from the Executive Committee: "To secure rights to manufacture leading implements . . . is pre-eminently a duty of the National Grange, and a measure of the greatest importance, directly, because the profits of manufacture will thus be controlled by the Order, as well as the profits of transfer or dealing; indirectly, by securing facilities that will favor the introduction of manufacturing establishments in districts at present far removed from them, and where their products are in demand." The plan of having the farmer's machinery manufactured at his door and under his supervision was much better as a statement of protectionist doctrine than as a guide to safe investment. The policy of the meeting of 1875 indicated that, before it was too late, the National Grange recognized that there was danger of going too fast, and that its province was rather to devise plans for the use of the order than to plunge into enterprises itself. It therefore sounded a note of caution, and first issuing a scheme for co-operative joint-stock stores based on something found in this country, proceeded to work out a more elaborate system on the model of the Rochdale Pioneers. Various English publications on co-operation were distributed among the order, and an envoy was sent to England to confer with English co-operators. The result was a new set of rules, closely following the Rochdale plan, and insisting on the feature of investing the profits of trade for the stockholders on the basis of purchases, as opposed to the simple joint-stock arrangement of the earlier scheme, which had been largely put in practice. After a prolonged stay, the commissioner to England made his report, bringing from English co-operators proposals for dealings on a grand scale. The Grange was to subscribe one hundred and twenty-five thousand dollars toward the necessary shipping-depots, and all trade was to be carried on directly with England through a company to be known as the "Anglo-American Co-operative Company." The Englishmen followed the matter up by sending three men to the United States to confer with the Executive Committee. After looking over the ground, they proposed to erect their own warehouses at four seaboard cities, prepared to supply every article of clothing and every farm-implement needed by Patrons at a discount of ten per cent, and to receive in exchange every variety of farm-produce at the market price, provided that the Grange would concentrate its purchases upon them. But by this time the ardor of the Patrons had been cooled by reverses in local experiments, and the Executive Committee was unable to make the necessary guarantees. The National Grange's efforts now subsided into protests and warnings against the commission and joint-stock ventures so common in the order, and pleas for the Rochdale system. Many enterprises were undertaken upon this basis, proving, if not highly profitable, at least not disastrous. Some are still in existence, notably the "Texas Co-operative Association." But, in general, the warning came too late. The Patrons had been too impatient to grasp the anticipated gains, and had burned their fingers.

The step from co-operation in the National, to co-operation in the State and District, Granges is one from theory tinged by practice, to practice pure and simple. The craze for co-operation was like that for gold in 1848. The first and simplest step was to appoint a profusion of buying and selling agents, usually on salaries from the State Granges. But a few losses by mismanagement and rascality were enough to deter the farmers from trusting their produce to selling-agents. The system of agencies for buying only was not open to the same risks, but its utility differed in different States. For Iowa, where every farmer raised grain and wanted plows and reapers, an agent could buy to great advantage. The Patrons there gave figures to show that they saved fifty thousand dollars in one year on plows and cultivators alone. In the same year they bought fifteen hundred sewing-machines, at a reduction of forty-five per cent from retail prices. Local dealers were driven out of business. In New York, on the other hand, where the farmers are dairymen, grain-growers, nurserymen, and hop-growers, a State buying-agency was found useless, and was abandoned, after some hard experience, for a system of district agencies. These have effected saving in some instances, in others proved unprofitable, partly owing to the outcroppings of mean human nature among those most clamorous for the benefits. The "State Women's Dress Agency," in New York city, lasted longer, but, strangely enough, the

Patronesses preferred to buy their own dresses, and it finally expired. The States did not stop with agencies. They too began to buy patent-rights. There was an idea that all the principal machinery used by the order should be manufactured within it. Flouring-mills, elevators, tobacco and grain warehouses, were established. Some ventures were unsuccessful from the start, and at once clamored for subsidies. Others boasted of the greatest prosperity, one making a dividend of fifty per cent the first year. In 1874 two thirds of the elevators in Iowa were in Grange hands. The experiment of shipping provisions directly to Southern Grange centers was undertaken. In 1876 the Patrons were said to own five steamboat or packet lines, thirty-two grain-elevators, and twenty-two warehouses. Some of these were local ventures, but the full treasuries of the State Granges furnished the capital for most of them. It is always easy to experiment with other men's money, and the State Grange officials found no difficulty in getting, with the Grange funds, into enterprises where disaster was inevitable. It came in every instance. The blow was so overwhelming in some States (Arkansas and Nebraska for example), that they dropped at once from the order. District Granges disbanded for fear of being held individually liable for State Grange debts, and the very name Granger became a reproach. In other States the Grange was greatly weakened, but survived. In Iowa a few hundred of the faithful have struggled on for years, the officers receiving no salaries, but devoting all receipts to the debt, left as a reminder of past glories. Professor R. T. Ely, in his recent book on "The Labor Movement in America," expatiates on the "grand results" achieved by the Patrons in co-operation, and credits the absurd statement that Grange savings in this way amounted to twelve million dollars in one year! Unfortunately, the greater number of enterprises were "grand" chiefly in failure, a fact of which Professor Ely seems never to have heard. About all that survived the wreck of the later seventies were mutual insurance companies, principally fire-insurance, and co-operative stores. At present, Grange insurance companies are reported from more than half the States and from Canada, and Grange co-operative stores are even more widespread. Successful buying-agencies still exist in five States, and the Delaware Patrons have a fruit-exchange. The most interesting state of things is found in Texas, where there are about one hundred and twenty-five Grange stores established on the modification of the Rochdale rules, and banded together in a State association. This holds annual meetings, contributes two thousand dollars to keep Grange lecturers in the field, and reports steady prosperity.

Much of the later history of the Grange has been anticipated in treating of railroad legislation and co-operation, but its decadence merits a little closer attention. Only those interested in agricultural pursuits were eligible for membership, but, in the unprecedented growth of the order under the labors of twelve hundred deputies, it was impossible to keep out men who were farmers only to the extent of a garden or back yard. In those days lawyers, doctors, merchants, discovered in themselves a marvelous interest in agricultural pursuits, and joined the Grange. As a Granger remarked, they were interested in agriculture as the hawk is interested in the sparrow. Two Granges were organized in New York city; one, the "Manhattan," on Broadway, with a membership of forty-five wholesale dealers, sewing-machine manufacturers, etc., representing a capital of as many millions; the other, the "Knickerbocker," one of whose first official acts was to present the National Grange with a handsome copy of the Scriptures—a gift causing some embarrassment. A similar one was organized in Boston, which made great trouble before it could be expelled; and one was found in Jersey City, with a general of the army as its master, a stone-mason as secretary, and the owner of a grain-elevator as chaplain. But discordant elements were not all from other professions. Thousands of farmers had been carried in by the enthusiasm of the movement, with no idea of the nature and aims of the order. Some expected to make a political party; others, to smash the railroads; almost all hoped to find in co-operation a panacea for poverty. There was great lack of discipline, but no discipline could have harmonized such a body. The first outbreak was in the direction of democracy. Lay members were eligible to but four of the seven degrees, and this was denounced as aristocratic, opposed to the spirit of democratic institutions. Along with this came the cry that the National Grange was growing too rich. In vain it made liberal donations of seeds and provisions to sufferers by grasshoppers and floods, and spent large sums in distributing crop-reports among the order. The clamor continued till the faint-hearted in the Charleston session in 1875 carried a measure to distribute $55,000 to the subordinate Granges—about $2.50 to each! Prominent Grangers have maintained that the causes of Grange decay are to be found in this and the other measures of the same session curtailing the power of the National Grange. The true cause has been seen to lie deeper, in the failure of business enterprises. These measures had some influence, however. They were the beginnings of endless tinkering with the constitution, and the cause of quarrels innumerable. Among other quarrels was one with the Grange of Canada, over the question of jurisdiction. Soon afterward came the first open break in the ranks. An Illinois Grange voted to disband, alleging pecuniary reasons and the autocratic rule of the National Grange. Many still had dreams that the order was to spread over the world, but the co-operative leaven had begun to work, and there was soon no mistaking the tendency to decay. At the annual meeting in 1876, four thousand Granges were reported delinquent. Salaries were at once reduced—the master's from $2,000 to $1,200, and the secretary's from $2,500 to $2,000. It was vainly attempted to stem the tide by issuing an official organ, the "Grange Record." In 1879 the master's salary was dropped entirely, and the secretary's reduced to $600. A bill for services from Herr Prenzel, who had been working for the order in Germany since 1875, was dismissed with little ceremony. The National Grange was not poor, having always kept about $50,000 to its credit invested in Government bonds, but it had given up the idea of converting the world. But the low-water mark had been reached. Cash receipts in 1880 increased two hundred per cent over those in 1879. More Granges had been organized than in any year since 1874. The growth was especially marked in New England. The State Grange of Connecticut was revived after a dormancy of six years, and Maine began to claim more Grangers in proportion to population than any other State. At the session of the National Grange for 1885, held in Boston, delegates were present from all the States and Territories but eight. It is not easy to explain this growth, as there seems to be no great principle underlying it. Some New England Patrons are agitating free trade, but that can not be called a Grange issue, as Pennsylvania Patrons want protection extended to farm-products. The harmless practice of holding great fairs is gaining ground. At a recent one in Pennsylvania, lasting a week, the local paper says: "Over fifty thousand people were present on one day, and the sale of machinery direct to the farmers ran up into the hundreds of thousands of dollars. Never were manufacturers and consumers brought into more direct and friendly relations." This is, perhaps, the latest development of Grange anti-middleman ideas.

The most enthusiastic Grangers at present are the farmers' wives and daughters, who are attracted by the social opportunities. In fact, the order seems to be going back to the educational and social basis of the founders, and its boasts are no longer co-operative ventures so much as Grange buildings and libraries, and the Grange schools that exist in several States. In these directions, and in what it has done to heal sectional differences between North and South, the Grange can boast its best achievements.

CLIMATE OF THE LAKE REGION.*

PERIODICAL CHANGES.

By BELA HUBBARD.

CONNECTED with our considerations upon the climate is a subject which has excited great interest since the first settlement of the country, and about which much has been written, for the most part vaguely. I allude to the variations in the levels of the lake-waters. Many causes contribute to create a perpetual fluctuation, or rise and fall, in these inland seas.

* From "Memorials of a Half-Century." New York and London. G. P. Putnam's Sons. 1887.

1. A possible lunar tide; but so small and so broken in upon by greater causes as to be of very uncertain value.

2. The winds, which often cause a difference in level of many feet; strong westerly winds causing a rise at one place, and easterly winds at another. These changes are irregular and transient, but often considerable in amount, ranging from two to five feet.

3. Annual variation attendant upon the seasons and confined to the year. This kind of fluctuation is a winter and summer movement. The supply from streams and rains being wholly or partially checked in the cold season, the water is gradually drawn away, lowering the general level, which reaches its lowest ebb about January or February. As spring advances, with melting snows and increased rainfall, the waters rise gradually, and attain their greatest height in June or July. They then begin to fall again to their winter level. The extreme of this variation is about 2·30 feet, and is about the same in Lake Erie as in Detroit River.

4. A rise and fall of the waters of the lakes and their connecting channels, extending through several years, and amounting to an extreme difference of five feet. Upon this kind of fluctuation Colonel Charles Whittlesey has bestowed the name of "secular variation."

The causes of this variation were long involved in much mystery. According to the old French tradition, it is independent of the seasons, and follows periodical intervals of seven years. To what extent these intervals of high and low water are regular in their recurrence, and how far they are connected with meteorological or astronomical causes, can be determined only after continuous and exact observations for a long series of years.

It is hardly more than a decade since the United States Signal Service has given scientific exactness to observations, and not over thirty years since thoroughly reliable statistics have been tabulated. Records of independent observers often differ widely, and though the writer has culled from different sources data sufficient to enable him to construct a diagram for this region, covering the past fifty years, and even more, many of these data are of uncertain value. For a period of thirty-three years, beginning with 1853, a record has been kept by the Detroit Water Board of the daily fluctuations in the level of the river, and partial records exist of other years since 1835.

In a comparison between the height of water in the river and the rainfall at Detroit, no conclusions drawn from these data will apply rigidly to the lakes above and below. The river-levels are influenced not alone by the precipitation on its borders, but by the supply from above. Other causes contribute to its irregularities—local rains, confined channel, rapid current. While a sudden increase in the precipitation will affect the broad surfaces of the lakes uniformly, a rise would take place at such times in the confined straits to a disproportionate extent. In discussing this so-called "secular" variation it becomes necessary to procure data from outside sources.

Milwaukee represents well Lake Michigan, and Cleveland Lake Erie. Each is about half-way between the head and foot of the lake upon which it is situated, and where the changes may fairly be considered as means of the whole. From Milwaukee I have a table of the rainfall from 1844 to 1886, and of the "secular" variations of Lake Michigan from 1859 to 1882. From Cleveland, of the rainfall from 1856 to 1886, and of the lake variations since 1859.

At each of these places the standard or plane of reference is the high water of 1838. The standard at Detroit is an arbitrary one, namely, the water-table at the Hydraulic Works. The mean of the last fifty years is five feet below that standard, and corresponds, as nearly as I can determine, to one foot below the *mean* of 1838, and two feet below the extreme of June of that year.

Of the fluctuations of the water prior to the period mentioned the only data are derived from the recollections of old settlers. These, though often indefinite and sometimes faulty, are yet of great value. Dr. Houghton, in his report of 1839, gives certain concordant statements of old inhabitants, going back as far as 1800. In a paper published in "Smithsonian Contributions," volume xii, Colonel Charles Whittlesey has collected items from all sources within his reach, going back as far as 1788. Vague as many of these details are, there is so much that is of definite value, that it seems to me possible to construct a curve of the levels of Lake Erie for the whole period, which should exhibit, with tolerable accuracy, the highest and lowest extremes at least. As I propose to use these aids in formulating certain conclusions, I ought here to give the reader opportunity to form his own judgment as to their value and authority.

To begin, it may be taken as universally admitted that the lakes were at a higher level in 1838 than at any known period before. In confirmation of this is the fact, among others, that forest-trees of a century's growth and more were killed by the high water of that year. Two other eras of very high water are reported by tradition, the one in 1814–'15, the other in 1788. Facts and comparisons reported render it nearly certain that at both these periods the levels attained to somewhere near the standard of 1838. At the former date much land and many buildings were submerged on the Detroit and St. Clair Rivers. Many statements also bear upon the fact of high-water periods between the several dates mentioned. Dr. Houghton relates, on the authority of Colonel Henry Whiting: "Old inhabitants agree that the water was very high in the years 1800 to 1802, roads along Detroit River being completely inundated, and even rendered impassable." And further, that in 1821 the river began to rise, "and in 1828 had again attained the elevation of 1815, submerging wharves that had been built in the interval; and it so remained until 1830."

As to low extremes, it seems well ascertained that the one of 1819–'20 was the lowest known prior to 1841—the low depression which succeeded the extreme elevation of 1838. Presumably it was the lowest known during the century. Old Frenchmen of Detroit had no tradition of a level below that of 1819. Statements regarding the stage of the water always make reference to the acknowledged highest and lowest years. Thus we are enabled to fix upon and determine with considerable exactness the relative values of other low periods. The water in 1796 was reported by lake captains to be universally low, and indicating a level five feet below the high extreme of 1838. From that year, they say, it rose rapidly, and continued to rise until 1800. Colonel Whittlesey says: "It was ascertained generally that the water was low in 1790, 1796, 1802, and 1810. Between February, 1819, and June, 1838, there was a continual rise, amounting to 6 feet 8 inches." Old settlers compare the low stage of 1802 with that of 1797. In 1806 it was reported at Cleveland lower than in 1801–'02, and declining regularly to 1809–'10. At this date it was reported nearly as low at Buffalo as in 1819. From 1828 it was reported as falling, and in 1833 was 3 feet 10 inches below June, 1838. From this year on we are able to trace the "secular" periods of lake and river with considerable accuracy; and data also exist in regard to other elements which it is proposed to include in our discussion. I give two diagrams, intended to exhibit graphically what is shown more in detail in the tables.

Diagram No. 1 shows the curve of high and low water of Lake Erie from 1788 to 1838, constructed in accordance with the above data. In connection with it is given the sun-spot curve, from 1769 to 1838, according to Wolf's tables, reference to which will be made hereafter. The lengths of the periods are also shown, and the lag of the lake periods behind the sun-spot periods.

Diagram No. 2 gives similar data for the term of years from 1834 to 1887, including, in addition to the curves of lake-levels, those of the rainfall and of the temperature (registered at Detroit), and of the sun-spots, according to Wolf's tables.

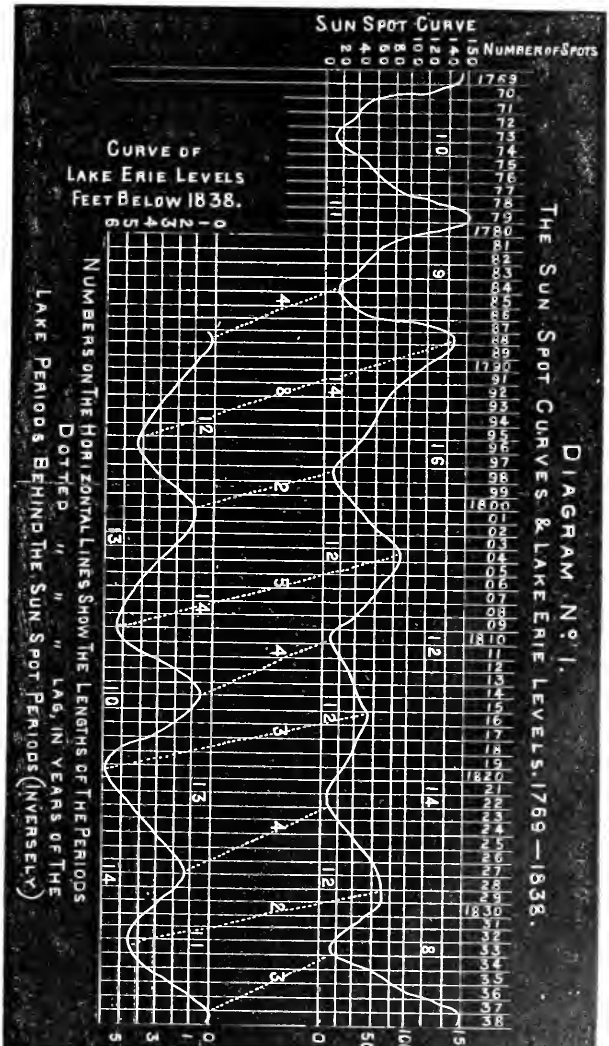
In these diagrams my endeavor has been to exhibit by curved lines the recurring maximum and minimum periods, eliminating intermediate and irregular fluctuations.

Confining our attention for the present to the curve of rainfall (Diagram No. 2), let us endeavor to ascertain whether among the many and often abrupt fluctuations it is possible to discover any periodicity.

The vertical columns represent years. In the portion devoted to the rainfall variations the horizontal lines represent the number of inches of annual precipitation.

It will be noted that the years 1836 and 1880 were times of excessive rainfall. Between these two extremes, and about equidistant, appears another strongly marked period of excess, culminating in 1855. Again, between these three maxima are two lesser extremes, culminating in 1844 and 1868. Thus our curved line marks five periods of maximum rainfall.

Of low extremes we note four, which have their culminations in the years 1839, 1850, 1860, and 1872.

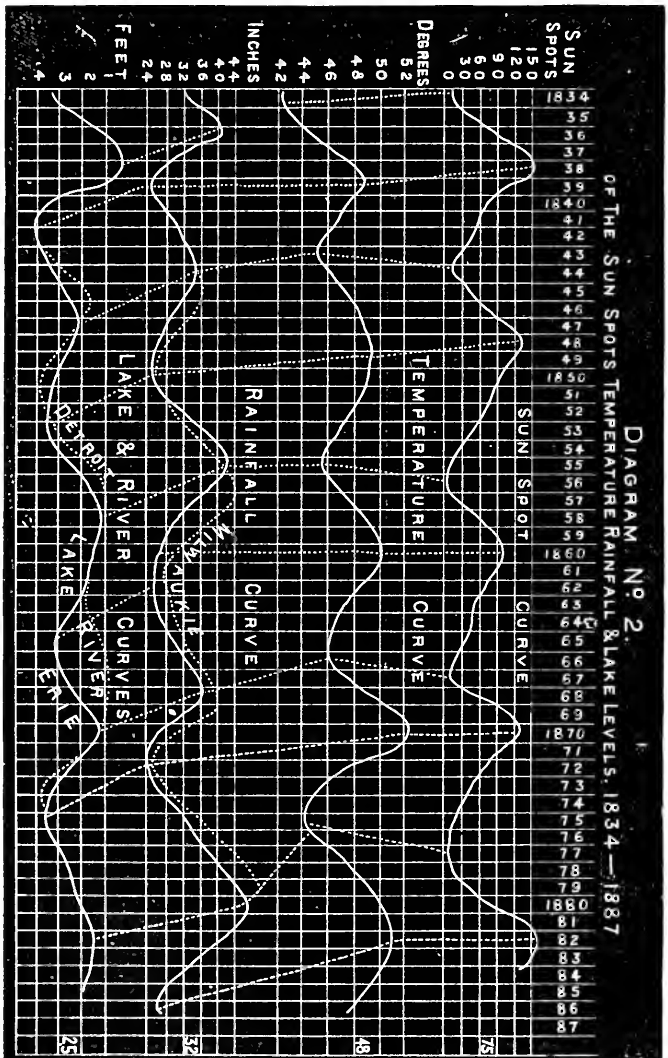


The intervals between extremes vary from eight to fourteen years, the general mean being eleven years.

Let us now compare with these curves those immediately below, and which represent the periodic changes in the levels of Lake Erie during the half-century.

Here the horizontal lines represent the number of feet below the plane of 1838.

It requires but a glance at the diagram to show that some relationship exists between the lake and rainfall periods. The first impression conveyed is that the curves are in opposition—that the high in one corresponds with the low in the other, and the reverse. But I think



the true relation will be made to appear when we notice the important fact (which I endeavor to render more apparent by dotted lines), viz., that the water extremes lag behind the rainfall extremes—following them at intervals of from two to four years. Thus the seeming want of coincidence is reduced to harmony. It will also appear that the rainfall extremes are not only followed invariably by corresponding fluctuations in the water-levels, but that these succeed each other in quite as marked and uniform periods.

The rainfall maxima of 1836, '44, '55, '68, and '80 have their corresponding extremes in the water maxima of 1838, '47, '58, '70, and '82 —the intervals or lag varying from two to three years. The rainfall minima of 1839, '50, '60, '72, and '86 have corresponding lake minima in 1841, '53, '65, and '75—the intervals varying from two to five years. The mean lag is 2·9 years. The true relation—dependence—of the lake periodicities upon those of the rainfall is thus clearly shown.

It will be observed that I have chosen to consider the Lake Erie levels rather than those of Detroit River. I do so for the reason that the relations of the former to the precipitation are more simple and direct, and are not influenced by causes already pointed out (page 375), which tend to create irregularities in the river. A marked illustration is shown between the years 1859 and 1870—where dotted lines represent the rainfall at Milwaukee, and the river-levels as compared with those of Lake Erie—of the effect of excess of precipitation on the lakes above, in keeping up the river to a disproportionate extent.

I do not consider it necessary to examine the various theories which have been broached from time to time, in explanation of the lake periodical fluctuations. Nor will I undertake to explain all the irregularities of the river and lake, which would demand many factors that are wanting to the present discussion. It will suffice if I have succeeded in making clear the relations which exist between the variations of the water-levels and the rainfall, and in defining their periodicities. Probably few at this day would dispute the fact that the rise and fall, or "secular" variations, in the waters are dependent upon the rainfall. This is the first attempt, to my knowledge, at demonstration of their true relations.

Thus far I have not alluded to the important element of Temperature in its relation to rainfall. That an intimate relation exists is an admitted fact ; it shall be my endeavor to show what this relation is.

In the portion of the diagram devoted to the Detroit temperature curve, the horizontal lines represent the degrees of mean annual temperature, which varies from 42°, the lowest, to 52°, the highest extreme. Considering temperature as a controlling element, we should expect to find a close correspondence between its curves and those of the rainfall. And we do so find, as is shown by the diagram. But, while the maxima and minima of the rainfall and the lake are directly as each other, we discover that those of the rainfall and the temperature are inverse to each other. For a full discussion of the relation between these two elements, no doubt we ought to take into account other important factors—barometric changes, winds, magnetic and other phenomena. The conclusions of this paper are deduced only from the data presented. Let us now compare the curves.

The *maximum* temperature periods of 1839, '49, '60, '70, and '82 at Detroit will correspond to the *minimum* rainfall periods of 1839, '50, '60, '72, and '86—if we credit to the latter a lag or interval behind the temperature periods of 0 to 4 years. The *minimum* temperature periods of 1834, '43, '55, '66, and '75 correspond to the *maximum* rainfall years 1836, '44, '55, '68, and '80, with a lag varying from 0 to 5 years; the mean of the lag being 1·8 years.

If this showing reverses the commonly received opinion that high temperature is followed by extreme rainfall, I can only say that the facts, as I find them, do not warrant such conclusion. Let the reader attempt to connect either the maxima or the minima of the curve of temperature with the like periods of the rainfall, and he will find it necessary to admit intervals of from six to nine years, a conclusion which would be inconsistent with any influence whatever.

I now turn to another element, or phenomenon, which will be found to have an intimate bearing upon our investigation.

Recently, much speculation has been elicited by the ascertained periodicity of spots on the sun's disk. It is now an admitted fact that the increase and decrease of the spots affect the magnetic needle, and influence the earth's magnetic and electrical condition. The extent to which these affect the meteorology of our planet is a moot question with the learned on these subjects.

Some noted observers in Europe and India maintain the theory of an influence exerted by the sun-spots upon the rainfall, and this directly as the number of the spots. In this lake region, attempts to establish or define these relations have been few and unsatisfactory. It will be my part to show that the sun-spots do decidedly influence the temperature, and indirectly the rainfall, and that the curves of temperature correspond directly with those of the sun-spots. This correspondence holds not only as regards the maxima and minima periods, but as to the general features of the two curves.

Wolf's tables of the sun-spots from 1769 to 1882 show ten periods of maxima and as many of minima, the spots ranging from 0 in a minimum year to 150 in a maximum year. Of these periods, one half are embraced within the sixty-six years from 1769 to 1834. For this cycle there are no reliable statistics of temperature and rainfall; so that my data are confined to the sun-spots and the lake periods, of which I present a tabular statement, as supplementary to Diagram No. 1.

Table No. 1 exhibits in groups:

1. The years of maximum and minimum sun-spots from 1769 to 1834, according to Wolf's numbers—the maxima and minima in separate columns.

2. The years of maximum and minimum levels of Lake Erie, which are given in feet and tenths below the plane of 1838—the maxima and minima in separate columns.

3. The lag, or interval in time at which the periodic changes in the lake follow *inversely* those of the sun-spots. One column gives the number of years lag of the lake maxima behind the sun-spot minima; the other of the lake minima behind the sun maxima.

4. The sun and lake "*periods*." In one column are given the number of years between each maximum of sun-spots and the next preceding maximum, and alternately, the number of years between each minimum of spots and the preceding minimum. In the other column are given the like data for the lake periods.

TABLE No. I.

Maximum and Minimum Periods of Sun-Spots and Lake Erie, 1769–1834.

YEARS.	SUN-SPOTS.		LAKE ERIE LEVELS.				PERIODS.	
			Below 1838, feet and tenths.		Lag.			
	+ No.	— No.	Plus.	Minus.	Lake + behind Sun —.	Lake — behind Sun +.	Sun, years.	Lake, years.
1769	140							
1773	...	10						
1779	155	..	..	..	..	..	10	
1784	...	12	..	..	..	..	11	
1788	140	..	0.5	..	4	..	9	
1796	..	..	..	4·5	..	8		
1798	...	5	..	..	..	..	14	
1800	...	..	2	..	2	..	..	12
1804	85	..	..	..	..	..	16	
1809	...	..	..	5	..	5	..	13
1810	...	0	..	..	..	..	12	
1814	...	..	1	..	4	..	..	14
1816	55	..	..	..	..	..	12	
1819	...	..	..	6	..	3	..	10
1822	...	0	..	..	..	..	12	
1827	...	..	2	..	4	..	..	13
1830	75	..	..	..	..	..	14	
1833	...	..	..	3·5	..	2	..	14
1834	...	10						
Means	...	..	1·4	4·7	3·5	4·5	12·3	12.6

The phenomena which this table makes apparent are: First, that what I have called the *sun and lake periods* approximate in length, and the means of each are nearly identical—12·3 and 12·6 years. Second, that the sun and lake periods are not synchronous, but that the changes in the lake follow at considerable distance (lag) behind the sun-spot times. Also that the lake maxima lag behind the sun-spot minima less than do the lake minima behind the sun-spot maxima, the means being, respectively, 3·5 and 4·5 years. That is to say, the waters fall less rapidly than they rise, by the mean of a year. We shall see presently how far these statements tally with the data drawn from fuller sources, for the half-century succeeding.

Let us now turn to Diagram No. 2, which exhibits the sun-spot curves from 1834 to 1884, paralleled with those of the temperature, the rainfall, and the lake.

We see five "periods" of sun-spot maxima, culminating in the years 1838, '48, '60, '70, and '82, the number of spots at each varying from 95 to 150. And five of sun-spot minima—in the years 1834, '44, '56, '67, and '77, the spots in each varying from 5 to 10. The maximum periods recur at intervals of ten to twelve years—and the minimum periods at like intervals—the means being 10·8 years. With the aid of the accompanying Table No. 2, we may proceed to compare results.

Table No. 2 aims to give in a succinct form all the data which our discussion requires. These are grouped in columns, as follows:

The first group gives (in three columns) the sun-spot data, in the same manner as in Table No. 1, viz., the years of maxima and minima, the number of spots at each, and the lengths of the periods.

The second or temperature group gives (in two columns) for those years of maxima and minima which conform to the sun-spot maxima and minima, the degrees of temperature (the mean of the year at Detroit), and the lengths of the periods.

The rainfall has three groups. The first gives for Detroit (in three columns) the maximum and minimum periods, the precipitation in inches at each, and the lag or interval at which each follows, inversely, behind those of the temperature. Like data are given for the rainfall at Milwaukee and at Cleveland, so far as I possess data, omitting the column of lag.

For the water-levels there are two groups, each showing (in three separate columns) the periodicities, the measurements in feet and tenths below the plane of 1838, and the lag behind the rainfall at Detroit.

Lastly are given (as in Table No. 1) the lag of the lake behind the sun-spot periods—lake maxima behind sun-spot minima, and the reverse.

My aim is to exhibit those fluctuations in the elements under discussion which conform to the sun-spot periodicities, according to the law which seems to govern, viz., temperature directly as the sun-spots; rainfall inversely as the temperature; lake-levels directly as the rainfall, and the periodical changes in each, following uniformly those of the preceding or influencing element by a lag of short interval; and this increasing in length according to the remoteness from the original source of influence.

When we consider that the sun is itself the ultimate source of all our meteorological phenomena, the fact that the periods of greater and less energy indicated by spots on its disk have a well-marked relationship to the temperature and rainfall is not surprising. While there are many fluctuations for which no solution is attempted, it suffices if we are able to point out well-defined maxima and minima periodical fluctuations which conform to each other within small limitations.

The proof does not rest alone upon the Detroit observations. Though the rainfall at Milwaukee and Cleveland differs, often considerably, in times and amount, from the Detroit record, we find a close conformity in the periods. In fact, there is almost identity in the periodic means of all the elements contained in the table.

TABLE No. II.

Maximum and Minimum Periods of Sun-Spots, Temperature, Rainfall, and Water-Levels, 1834–1887.

YEARS.	SUN-SPOTS.		TEMP. DETROIT.		RAINFALL.							WATER-LEVELS.						LAKE ERIE LAG.	
					DETROIT.			MILWAUKEE.		CLEVELAND.		DETROIT RIVER			LAKE ERIE.				
	No. of spots.	Periods—years.	Degrees.	Periods.	Inches.	Periods.	Lag behind temperature.	Inches.	Periods.	Inches.	Periods.	Feet below 188.	Periods.	Lag behind rainfall.	Feet below 188.	Periods.	Lag behind rainfall.	Max. behind sun min.	Min. behind sun max.
1834	10?	...	42 ?	12 ?															
1836					40		2												
1838	150	10										0	11 ?	2	0	11	2	4	
1839			48·3	10 ?	24	8	0	25?											
1841												4·5	9	2	4	9	3	...	3
1843			45	9															
1844	10	10			34	8	1												
1845												1·5	7	1					
1847															2	9	3	3·5	
1848	125	10						33	11										
1849			49·3	10															
1850					26	11	1	26	11			3·5	9	0					
1853															3	12	3	...	5
1855			46	12	43	11	0												
1856	5	12																	
1858								45	10	44	10	0·5	13	3	1·2	11	3	3	
1860	95	12	49	11	28	10	0	24	10										
1861										32	11								
1865												1	11	5	2·8	11	5	...	5
1866			46	11															
1867	9	11																	
1868					36	13	2												
1869								38	11										
1870	132	10	52	10						47	12	1·4	12	2	1·6	12	2	3	
1872					24	12	2	28	12	32	11								
1875			44	10								2·5	10	3	3·5	10	3	...	5
1877	5	10								52	8								
1880					47	12	5	48?	11										
1882	160	12	51	12								1·3	12	2	1·5	12	2	1	
1886					25	11	4			26	14								
Means.	...	10·8	...	10·7	..	11	1·8	...	10·9	...	11	...	10·6	2·4	...	10·8	2·9	3·5	4·5

The two columns (on the right of the table) showing the lag of Lake Erie behind the sun-spots at each period, furnish a remarkable confirmation of the general conclusions. Comparing the two tables, it will be seen that the mean periodicity of the sun-spots is larger for the first half-century than for the last by 1·7 years. Yet the same relation to the lake periods is maintained throughout both cycles. The lag for the maxima and for the minima periods is the same in both tables, the means being 3·5 years and 4·5 years, respectively. This result is not merely remarkable ; it would be incomprehensible on any other theory than that here contended for. Its truth or fallacy the reader has the means of determining if he will closely study the details given in the table and the diagram.

Another feature of too much importance to escape attention is the difference in all the curves between the scales of increase and of decrease. This is shown by the diagram, and is computable from the tables. Thus, the times of increase in the sun-spot curve, from minima to maxima, are almost uniformly four years ; those of decrease, or from maxima to minima, six to eight years. The temperature curve attains its maxima at the same time or a year later than the sun-spots, but its minima are often reached a year earlier than those of the sun. The result is to nearly equalize the times of temperature increase and decrease, the rising scale being accomplished in 5, and the falling in 5·4 years.

The rainfall curves show a closer correspondence with the sun's times, but in reversed order, the rising scale being accomplished in about 6·5 years, the falling in about 4·5 years.

The lag of the lake curve behind the rainfall at its minima exceeds that of its maxima by nearly one and a half years (3·75 and 2·4). The tendency is to equalize the times of the lake increase and decrease, so that the "secular periods" exhibit nearly equal scales (5·4 and 5·25). During the cycle from 1779 to 1834 the scales differ more—rising 5·75 and falling 6·75 years. These are the closest correspondences I have been able to find to the traditional French period of 7 years.

Thus the cycle of change is "never ending, still beginning." On its restless sea, man is tossed at the caprice of billows, whose wave-lengths are intervals of eleven years. The law of change runs through the scale from cold to warm, and from warm to cold in nearly equal times, but demands half a year's less time in the descent from wet to dry ; while the upward scale, or from dry to wet, is longer by two years than the downward scale of temperature, and with intervals or lag of one and a half years.

To sum up, it seems to me demonstrated, as regards this region :

1. That the so-called "secular" changes in the levels of the river and lakes are dependent upon the rainfall.

2. That these changes in their maxima and minima fall behind the rainfall extremes in time, varying from two to five years.

3. That the times of maximum and minimum rainfall occur *inversely* as the temperature, and follow after, with mean intervals of one to four years.

4. That the times of maximum and minimum temperature occur *directly* as the sun-spots, with small or no intervals.

5. That the times of high and low water of the lakes and river follow behind the sun-spots, inversely, by a double lag—of lake behind rainfall and of rainfall behind sun-spots—the mean of both being four years.

6. That the periods of maximum and minimum sun-spots, temperature, and rainfall have an intimate relation to each other, and that this relation appears in the respective periodicities, which differ but little, while the means are nearly identical.

The question naturally arises, How far do the conclusions here recorded afford a foundation for forecasting the meteorology of the future?

If all the wave periods were of equal lengths and times, with sufficient allowance made for other factors not within our present discussion, we ought to do so with exactitude. But though our sovereign governor—the sun—exhibits a considerable degree of regularity in the increase and decrease of his spots, he has not as yet admitted us into the secret either of the cause or of the extent and frequency of his variations.

We have also seen that while the curves of temperature and rainfall are controlled by the sun-spot periods, their times of maxima and minima are not therefore synchronous. This is true to some extent as between the sun and the temperature, while those of the rainfall are not only inverse to, but lag behind, the temperature extremes, with varying times. There follows, therefore, a difference, both in the lengths and the times of the periodicities of each.* Owing to this lag, and its variation in time of one to four years, it follows that when the temperature curve is at its maximum or its minimum, that of the rainfall is not necessarily at its lowest or its highest. In fact, such a conjunction may be brought about in the progress of time, that a wet period may correspond in time to a warm one, or nearly so, and *vice versa*, and yet the law of opposites continue absolutely persistent.

This observation applies with even greater force to the lake curves, the lag in which is uniformly greater than in those of precipitation. Thus it has happened three times within the last half-century that high water in Lake Erie has corresponded in time with a high sun-spot period.

We observe, also, in noting the curves of temperature, as each approaches its low extreme, a sudden dropping of the temperature from

* While the periodic times in the curve of temperature range from nine to twelve ears, those of rainfall range from eight to fifteen.

a somewhat regular gradation, two to five degrees, during one, two, or three years. And in the approach to maxima a rise nearly as precipitate. This has its parallel in the rainfall—the precipitation experiencing a sudden increase in the high extremes of from eight to thirteen inches, and during low extremes of from four to eight inches, within one or two years.

In these records of the past century, imperfect as they are, will be found suggestions of more subtile and fundamental laws. The reader may notice a succession of three large sun-spot waves or periods followed by three lesser ones. They call to mind that succession of waves in the sea, called by sailors "the three sisters," and of the three-day weather period with which we are familiar. The conjecture may be warranted that we have here an indication of a major vibration of a six-period duration. It may be that all these cycles are but members of a grander whole, whose circles reach beyond our present ken, and to a perfect conception of which we may never attain, except perchance in that good time coming, when man's knowledge shall equal his aspirations. These considerations, and many more of which we are in ignorance, must enter into a calculation of the true horoscope of the future.

Nevertheless, we know that Nature governs by unvarying law. Assuming that her periodicities will bring about the same average results in the future as in the past half-century, I might undertake to be in some sort her interpreter of the coming events which cast their shadows before, along the pathway of a few unborn years; provided the same latitude be accorded me which was claimed by the old almanac-makers, to qualify the record with "about . . . these . . . days."

In each of our half-century cycles we have seen that there are five maxima and five minima of sun-spots, whose periodic times average for the first cycle a little more than eleven and a half years, and for the last cycle a little less. We may reasonably conclude that the next half-century will witness no material change, but that the like phenomena will continue, with a mean period of about eleven years; also, that the temperature and the rainfall will continue to exhibit their dependent phenomena as before. On this basis let us construct our diagram for the coming years.

Premising that the sun-spot curve, which for five years had been on the rising scale, attained its maximum in 1882, we may infer that the temperature is now on its descending grade, and should reach its minimum by 1889 or 1890. The yearly mean, which for ten years past has maintained an unusually high degree, with small range, will fall rapidly five degrees or more. "Look out for . . . cold . . . weather . . . about . . . these . . . years." The wary will also provide for cold winters about the years 1901, 1912, and 1923, and for epochs of high temperature about 1894, 1905, and 1917.

The rainfall, which, in accordance with its law of opposition and of lag, fell in 1886 to the low measure of twenty-five inches, is likely to continue small for a year or more to come. "Expect a . . . period of drought . . . about . . . this . . . time." The increasing precipitation following should reach its maximum soon after the beginning of the last cycle of the century. Maxima, or wet periods, may also be predicated for the years 1903 or '04, 1913 and '14, and 1924 or '25; and low, or dry periods, for 1895 or '96, 1909 and 1919 or '20, or 'thereabouts.'"

Following these leads, lake and river levels will rise to their culminations, it is probable, about 1894, 1906, 1916, and 1927 or '28, and fall to low levels about 1888 or '89, 1899, 1912 or '13, and 1921 or '22.

None need be surprised if the remaining years of the century witness disasters to the husbandman from drought and frosts, and to the business man from commercial disasters and stagnation in trade.

The new century, though opening with cold and wet, gives promise, in its first cycle, of returning general prosperity, inaugurated by abundant crops, and—if the nation be wise—by freer trade, restored commerce, satisfied wages, and solid wealth. Blessed be the sun-spots!

ENGLISH PHONOLOGY.

By THEO. H. KELLOGG, M. D.

LANGUAGES, like nations, have their growth and decay. Their evolutionary phases have, in many instances, after much learned research been clearly traced. A living language, however complete a development it may have attained, never preserves for any great length of time precisely the same grammatical structure or phonetic character, but it undergoes constant changes both of form and of sound.

The formative stages are usually attended by the most active organic alterations, and the decided mutations of the old, middle, and modern English periods are familiar to the linguistic student.

Within the last century, however, there have been no like radical changes in the English tongue, although many terms and phrases have become obsolete, and hosts of new words and expressions, chiefly technical and scientific, have been added. This permanency in the outer forms of the language has favored a greater uniformity in its elementary sounds. In England, at the present time, apart from the dialects confined chiefly to the ignorant in the various shires, and overlooking the slightly individual variations such as have existed at all times and in all languages, there may be said to be a uniform pronunciation of the mother-tongue among the educated classes. Even slight departures from this generally accepted orthoëpical standard, especially if they occur in the original elements of the language, strike the ear in an unfamiliar way like the sounds of a foreign tongue. Such departures have always arisen among colonists long and widely separated from the mother-country. It would be a contradiction, therefore, of all historical precedents in this regard if any American, native of the second generation, and bred in the United States, were to speak English, or any other modern language, with absolutely the same phonetic effect as a native of the mother-country. It is an undoubted fact that decided differences of English pronunciation exist between the educated classes in England and in the United States, and it is the object of this article to show in what these differences consist.

A careful comparative study of British and American English reveals the important fact that the phonetic differences are not confined to timbre of voice, or to accent and inflections, but that they are of a more radical nature, and are to be found in the component vowel-sounds themselves. It is not within the limits of this article to take into comparative consideration the broad subject of the various accents and dialectic peculiarities which exist in various parts of the United States and England, but it is intended to confine this phonological analysis to such patent differences of speech as prevail between educated Englishmen and the great mass of the more intelligent natives of this country. As social and business ties between the two countries are becoming constantly stronger and more direct, attention is more frequently drawn to these existing inconsistencies of utterance. Some Americans have in a measure modified their pronunciation to accord with English usage, and some of our actors especially have been at no small pains to reform their speech in accordance with the English standard which has come to prevail in the principal theatres of this country.

It would greatly facilitate the analysis here undertaken if there were some universal alphabet of the elementary sounds of all languages into which a translation could be made of such special modifications of vocal elements as are to be described. The nearest approach to such a universal alphabet is the one invented by Alexander M. Bell, and now successfully employed in the instruction of deaf mutes, but as it is only known to comparatively few the more ordinary terms of orthoëpists will be used.

The subject will be presented in the following order:

1. Differences in vowel and diphthongal sounds.
2. Differences in the consonants.
3. Differences of syllabic accent.
4. Differences of emphasis, inflections, and vocal timbre.

The subdivisions under these heads will be as far as practicable in alphabetical order.

Differences in Vowels and Diphthongs.—First in the order of the vowels there are the various sounds of the letter *a*, which furnish some of the most typical instances of the departures of the American from the customary English pronunciation. The open sound of *a* in the word father is known as Italian *a*, and it was until the beginning of the present century in almost universal use in England, in a certain class of words in which Walker, and other lexicographers influenced by him, substituted short *a*, as in hat. The short *a* never became popular, and it was regarded by many as a species of learned affection, and in these words at the present day the open Italian *a* is very generally used in England. In the United States, on the contrary, the short *a* has come to be the sound employed by the vast majority of both the learned and less-educated classes in these instances. This sound of *a* occurs in a large class of words, such as last, past, after, ask, etc., and unfortunately it is not the explosive short *a* in hat as recommended by Walker, but a more prolonged and flattened sound, as it is uttered by most Americans, and one not authorized by any lexicographer. Fulton and Knight, and subsequently Webster, advised in this class of words a shortened sound of Italian *a*. Their intention, which was that this sound should differ in quantity only and not in quality from the Italian *a*, seems to have been misapprehended by certain cultivated speakers who, not satisfied with the flat *a* of common speech in this country, have adopted a sound intermediate in quality between short and Italian *a*. No such intermediate sound is ever uttered by native Englishmen. In the schools and universities, at the bar, in the pulpit, and on the stage, among officers of the army and navy, and among the learned and ignorant alike, the prevailing sound heard in these words in England is the open Italian *a*. It is not to be overlooked that a minority of New Englanders and a few Southerners have preserved this native English sound in this class of words.

But there is another series of words, like bath, aunt, half, path, calm, palm, etc., in which Americans depart still further from English usage by the employment of the flattened and prolonged *a* above mentioned. Now, it is needless to say that not only all English precedents but all lexicographers, American as well as British, demand the use of the full Italian *a* in these words; for, though there may be a choice of the short *a* of Walker, or of the open *a* in the first class of terms, there is absolutely no option in this instance. Helmholtz long ago proved that this Italian *a* has more harmonic overtones than any other vowel, and it is unfortunate that this most sonorous and musical sound should have so largely disappeared from English as spoken in the United States.

Another kind of *a*, known as long *a*, as in the word fate, is in reality like most of the vowels, of a composite nature, consisting of a fundamental and initial sound somewhat less open than Italian *a*, and a vanish in *e* long. This initial element is more open, and the diphthongal nature of *a* long more evident in the English than in the American pronunciation. This difference of utterance may be detected in a great many positions of long *a*, but especially in words like day, pay, etc., in which *y* represents the vanishing sound of the vowel. The long sound of this vowel in the article *a* before words beginning with a consonant—e. g., a man, a book, etc.—instead of the short and obscure sound, is also very common in the United States, but seldom heard in England.

Again, *a* before *r*, in such words as care, rare, and in many like positions, is also a double sound, with a primary vocal element resembling short *a*, and a final one, like *a* in are, according to some writers. This final element is more open as given by Englishmen, and approaches nearly Italian *a*, and the *r* is so slightly sounded, even by correct speakers, that in the mouths of many it probably has no organic formation, and thus corresponds to the provincial pronunciation given by some Southerners to the final syllable of words like door, drawer, etc., in which the open *a*, as in ah, is heard. As pronounced by most Americans, the final sound in these words is ur, and the final *r* has a real value, of which further mention will be made under the head of this letter. A few New Englanders and Southerners differ but little from the English usage, either with radical or terminational elements of *a* in the above instances.

A, as in walk, water, awe, fall, etc., is produced with a deeper and broader sound by Englishmen than by Americans. Some of the latter, in fact, pronounce such words so that they have more nearly the sound of short *o* than the deeply-formed vowel which issues from native British throats, and which is more profoundly formed than the German gutturals.

There is a corresponding difference, also, in the open and brief sound of *a* in what, wash, wallow, was, and in other words in which *a* has the value of *o* in odd.

The varieties of the vowel *e* also illustrate well the phonological differences of the vernacular of the two countries. The sound of accented *e* before *r*, not followed by a vowel or another *r*, as in her, term, mercy, etc., is that of *u* in fur, as uttered by most Americans, but English speakers give it a less guttural and more open sound, verging toward *a* in are, which sound is fully heard in a few instances as in clerk, pronounced clark in England. The correct sound between *u* in fur and *e* in met is only formed by the minority of speakers in this country.

The American long *e*, as in evil, is produced by a closer approximation of the tongue to the palate. The English name-sound of this *e* has less firmly closed lingual points of lateral contact.

The short *e*, as in met, contrary to American custom, resembles somewhat in quality long *a* as pronounced by many Englishmen. The latter always give a brief and obscure sound to *e* in the definite article before words beginning with a consonant, as the man, the book, etc., but in this country long *e* is often heard in these instances.

The long *i* in ice, shine, time, find, etc., like most vowels, is a phonetic compound, and it has Italian *a* as the radical and long *e* as the vanish, and the American transition from the former to the latter is quicker. The English *i* is more diphthongal and the radical element is a more open sound. In fact, this distinctly audible separation of the pharyngeal and lingual modifications of the vowel elements constitutes an important point in the comparative phonology of British and American English.

For the relative differences in *i* before *r* in accented syllables, as in virgin, third, etc., reference is made to the above description of *e* under like circumstances.

Short *i*, as in pin, as the equivalent of *y* final in beauty, badly, philosophy, etc., is the usual pronunciation in the United States, but British usage is a sound like *a* in quality, but more nearly identical with the open *e* (*e ouvert*) of the French. In fact, the frequent recurrence of this sound in English mouths at the present day is probably a relic of the influence of Norman French upon the Anglo-Saxon vernacular. The short *i* in pin has in American articulation its correct shut and explosive sound, such as exists in few other languages, but it more closely approaches long *e* in quality in British usage.

The long sound of *o*, as in home, bone, etc., has an initial element, formed more deeply in the throat than Italian *a* with a slight vanish in *oo*. The American differs from the English pronunciation in two ways—first, in that the labial modification is more decided with lips more nearly approximated ; and, secondly, in that the secondary element is omitted, and the *o* approaches short *u* among many New Englanders, as in stone, home, broke, spoke, whole, and many similar words. In most Americans, however, the difference is in the labial modification alone, and if the lower jaw is allowed to drop slightly in the articulation of the word blow, for instance, the long *o* with the enlarged labial aperture becomes almost identical with the native English sound of the same letter. On the other hand, there is in England a cockney and provincial separation of the posteriorly and anteriorly formed elements of this vowel which is not to be found among natives of the United States.

The short *o*, as in hot, odd, cot, etc., is formed by Englishmen with more laryngeal depression and greater posterior oral enlargement. The American short *o* issues from a less deep throat-formation, is not as broad, and is usually a less abrupt sound. The long sound of double *o* as in food, moon, etc., is one of the extremes of the scale of vowel elements, and it is uttered by Americans with greater labial contraction than is customary among Englishmen. New Englanders are wont to substitute for it the short sound of *oo* in foot, in words like broom, roof, root, and in a large number of similar words. British custom always retains the long double *o* in these instances. There is a British fault in Yorkshire and other northern parts of giving the long instead of the short double *o* in cook, book, etc., for although

Walker favored this pronunciation all good usage at present is opposed to it.

The name of the letter *u* consists of a double sound of which the first element is *y* or *e*, and the second is long *oo*. This compound nature of the vowel *u* is more generally marked in English than in American pronunciation. The most careful speakers are equally correct in the orthoëpy of this letter, but the majority of Americans substitute simply the long *oo* in words like tune, duty, Tuesday, nude, suit, etc. Some Southerners, however, fall into the opposite error, and give the initial element of this vowel undue distinctness.

In the short *u*, as in tub, sun, fun, etc., there is also a very perceptible difference between the pronunciation of the two peoples. The American sound comes forth naturally without any active oral adjustment—is similar to the *u* in furl, and is very much like that which is known as the neutral vowel. The English sound is shorter, more open, and is attended by a pharyngeal opening effort which is wanting in the American utterance. Similar corresponding differences obtain in a numerous class of words like hurry, flurry, etc., in which short *u* precedes the letter *r*.

The above are the chief phonological dissimilarities in the vowel scale, and attention is now asked to a few diphthongs. In the words boy, oil, join, etc., the diphthong *oi* is compounded of broad *a*, for the initial and short *i* for the terminational element. In English speech the broad *a* receives the full and decided stress of voice, and the final element is very brief, and the transition from the former to the latter is instantaneous. In American utterance the first element is dwelt upon, and the passage to the final one is less direct.

There is a want of agreement in the diphthong *ou*, in out, now, house, etc., as pronounced by Americans and Englishmen. Some of the former interpose between the vocal constituents of this diphthong a species of neutral vowel, while others use a much less open sound than Italian *a*, as the radical element. The latter fault is not confined to this country, however, but is equally a cockney peculiarity.

The chief points of phonetic variance in the consonants must now receive some notice.

Differences in the Consonants.—It is well known that Englishmen "drop their h's," as they express it. To be sure this practice is more common among the lower classes, but even among the highly educated, either through inadvertence or the force of early habit, this gross error occasionally occurs. The more ignorant, as if determined to be at cross-purposes with this letter, not only omit it from syllables in which it should be sounded, but they prefix it to words beginning with a vowel. Natives of the United States are singularly free from these erroneous practices.

The letter *r*, which is of such phonological importance in modern languages, has many divergent phases in British and American

English. The lingual or trilled *r* is properly used when this letter begins a word, e. g., round, rattle—when it is one of two initial consonants, e. g., proud, stream, and when it is between two vowels, as in spirit, orange, etc. In general this rough *r* is more distinctly trilled by Englishmen than by Americans, and their vibration is formed more anteriorly with a touch of the tip of the tongue against the hard palate. This vibration is very brief except in the most formal oratorical efforts, and it should be simply a double contact and never a distinct roll as given by the Scotch and Irish. *R* final or before a consonant, as in bar, born, has a guttural vibration in American utterance, but it is so smooth in English usage that the question has been raised by some orthoëpists whether it has any real value in these words or after a long vowel in the same syllable as in here, fire, our, and in many similar words. Whatever sound the obscure *r* may have in these instances is by Englishmen joined immediately to the preceding vowel or diphthong, but most Americans interpose between the previous vowel and the *r* a species of neutral vowel like *u* in urge, and slightly stiffening the tongue and raising the tip a little toward the dental arch they produce not a true dental *r* but a peculiar guttural *r*, which is in general use in the United States, except among some New Englanders and Southerners whose usage accords more exactly with the native English sound.

The writer's views of the English varieties of the letter *r* were published some years ago in England,* and a satisfactory physiological explanation of the soft *r* was then offered. In certain positions *r* has such slight value that some orthoëpists have regarded ah and are, for example, as identical in sound, while others, not admitting this view, have given no anatomical distinctions or rational theory as to this *r*. The original view advanced and still held by the writer is that the essential organic formation of this soft *r* is laryngeal, and consists in the tension and approximation of the true vocal ligaments so as to produce a friction-sound of the escaping breath. The breath thus roughened in its passage through the rima glottidis is the true basis of this *r*, which in some speakers receives a little additional value from slight pharyngeal constriction. Various analogies support this view of the organic nature of soft *r*, for several rough sounds are produced by the contraction of the "cordæ vocales" to a degree not productive of vocalization. The "spiritus asper" of the Greeks was thus produced. The fricative quality of our own *h* has a similar origin, and there is an obscure Teutonic *r* best heard among the Saxons having a like organic formation.

In July, 1878, the writer gave a written description of the English uvular and labial *r*'s. The former is the basis of what is popularly known in England as the Northumberland burr, and it corresponds to the uvular *r* of the Germans, and to the *r* "*grasseyé*" of the French.

* Professor Plumptre's, "King's College Lectures on Elocution," London, 1881.

If this *r* is produced skillfully by the vibration of the uvula alone it is to be distinguished from the lingual *r* only by a practiced ear, but if as in Swiss, German, and certain Gallic dialects, the pillars of the soft palate take an active part in its formation, it acquires a very harsh and disagreeable character. The substitution of *w* for *r*, by which real becomes weal, great, gweat, etc., is so far as personally observed English and not American. It is also probable that the use of *w* for *v*, as weal for veal, wery for very, is cockney, and never heard in the United States.

Did space permit much might be added to this description of the more patent differences of the elementary sounds of the mother-tongue as spoken by Americans and Englishmen, but syllabic accent, inflections, and vocal timbre also claim some attention.

Accent.—In all English words there is one syllable which receives greater stress of voice than the others. In words of two syllables the accent falls on the first one, and in polysyllabic words on the antepenult. The exception to this rule and the general laws of accent can not receive any notice here, but it is to be kept in mind that nothing more decidedly alters the phonetic character of English than changes in syllabic accent. A good pronunciation is distinguished by a firm and prompt attack of the accented syllables which are like the emphasized notes of a song, and they sustain the rhythmical flow of speech.

Apart from the primary accent there is a secondary and tertiary one laid on other relatively less emphatic syllables, and in the misuse of these is to be found one American peculiarity. In general, Englishmen have a more emphatic and superior delivery of the primary accent, but they are more wont to slur over the remaining syllables. This gulping of long words is offset by an opposite and equally great defect among Americans, who sometimes give the secondary accent in many words almost the same force as the primary, and their speech thus becomes drawling. Instead of giving one they employ a double decided accent as here marked in mil'ita'ry, mat'rimo'ny, ter'rito'ry, cir'cumstan'ces, and also in words of fewer syllables there is a like fault as in gi'gan'tic, im'men'se, rhu'barb, and a great many similar instances in which there should be a strong primary, and a very light secondary accent. To a native English ear this slow division and double accentuation of words is one of the most striking of the many peculiarities of American English.

Emphasis, Inflections, and Vocal Timbre.—For the learned the above orthoëpical differences are all important, but for the great mass of the people the vocal qualities embraced under the present heading constitute the most striking distinctions which the unpracticed ear recognizes between the vernacular of the two countries. Even the child without knowledge or thought of correct pronunciation is struck by the foreign tone of voice and the novel inflections. The American in London, though he may assume the dress and manners of the people, is immediately recognized by his speech, just as a Londoner in New York betrays his nativity by the first sentence which he utters. The facts under this heading are not fully within the limits of science, as they have not been classified by any definite laws, but they are sufficiently understood to afford some general grounds for comparison.

Emphasis is the stress laid upon particular words in a sentence, and it is to phrases what syllabic accent is to words. Englishmen excel in emphasis in common conversation, but they are less successful in its use in public speaking, whereas Americans seem to require the stimulas of public occasions for effectual delivery. The shifting of the emphasis from one word to another alters the entire meaning of sentences, and it has been even claimed by some that all who conceive a like meaning must make a like use of emphasis. This is a mistake, however, and the writer has convinced himself that there are actual differences in the employment of emphasis between Englishmen and Americans, but to discuss it would involve the natural rhythmical division of sentences—the laws of poise of voice and other lengthy subjects.

The rising, falling, and circumflex inflections express interrogation, affirmation, denial, and many shades of meaning and of feeling, and they always have a wider range when the emotions are deeply stirred. Englishmen use more inflections than Americans, and both in conversation and in sustained oratorical efforts they resort more constantly to the rising inflection. Even the most careless listener will be impressed with this fact. Their voice is modulated from the middle to the upper register very frequently, the conversational pitch is higher, and the grave monotone so common in this country is seldom to be heard.

The emotional modulations in different keys are more common in English conversation, and little children with plaintive appeals in minor keys, and also in their exultant moods most effectually express feeling by vocal modulation.

Finally, there is a physiological difference between Americans and Englishmen in the organs of speech due to changed climatic and other physical conditions of life. That the inherent quality of voice which characterizes different nationalities is due in part to differences of telluric and meteorological influences as well as to diversity of race and language can not be doubted. Instructors in vocal music know the various foreign voices and the effects of locality and climate in this regard. Vocal timbre, then, is a fundamental quality of voice distinct from syllabic accent, oral adjustments, emphasis, or inflections, and it is dependent in part on the individual's physical environment.

The English timbre of voice is generally harder and clearer than the American. It has been said that throat-troubles and pharyngeal relaxation are more common in this country, but reliable data are wanting to prove this The nasal tone so common in the United States is due exceptionally to uvular relaxation, and it is more frequently a bad habit which it is difficult for the possessor to recognize or to correct. Nasal intonation also has unfortunately grown to be an emotional modulation among Americans who unwittingly employ it in moments of embarrassment or indecision, and also when expressing religious emotion and various other feelings. Fortunately Americans are relatively free from the various kinds of stammering and affected hesitancy of speech so often heard in England.

The practical conclusions to be drawn from all of the above facts are briefly as follows:

1. That in keeping with the logic of past events in other languages American English, in a new physical and moral environment, has undergone a radical modification of vocal type.

2. That Americans can not be expected to conform to British customs so far as mere emphasis, inflections, and timbre of voice are concerned.

3. There are cogent reasons for efforts to keep the fundamental sounds of the language alike in the two countries, and it is the duty of all educated persons to correct such provincial or unauthorized utterances of the vowel-sounds as have been here described, and to strive to preserve the purity of the mother-tongue. If this article shall serve to awaken an interest in this important subject, or to aid any in its study its object will have been fulfilled.

THE MONKEYS OF DUTCH GUIANA.

By AUGUST KAPPLER.

THERE are eight species of apes in Dutch Guiana. The most conspicuous of them is the howling ape (*Mycetes seniculus*), which is also one of the best-known and largest of the race. It is called a baboon in the colony, *alouatte* by the Caribs, and *itoli* by the Arowaks. When standing up it is about three feet high, and weighs about twenty pounds. It lives in both the coast-regions and the interior, and eats fruits, leaves, and buds. Its big, scantily-haired belly, the thick, tawny skin of its back, passing into a purple-brown at the back of the head and the feet; its black face, with its strong set of teeth, and the prominence under its neck, covered with a long yellow beard, altogether make it one of the ugliest apes of tropical America. It lives in small troops of rarely more than twelve individuals, among which is always to be found an old, full-grown male, which takes a higher place on the tree than the others, and leads the lugubrious concert by which these apes are so broadly distinguished from other species. The windpipe of the male is much stronger and more complicated than that of any of the other apes, and is connected with a vocal apparatus composed of bone-substance of about the size of a goose-egg, which is set in the hollow of the under jaw. It looks from without like a wen, and acts as a sounding-board to strengthen the voice to an almost incredible extent. The females have a similar apparatus, but only about an inch in size. I do not know what it is that prompts the animal to set up its great cry. It is believed in the colony that it cries out only when the flood-tide begins, but this is wrong, for these apes howl at all times of day, and quite as much in the interior of the country, where there can be no tide. There may be some atmospheric influence which provokes the males to howl, while the females join in with them. There can not be a sexual impulse in the matter, for that would not make old and young howl together. I have had opportunities to hear this howling a great many times, and to observe the howlers from a very close vicinity. Every time, there sat an old male up in a tree, supporting himself on his fore-feet, and having his long tail, naked of hair on the inside for about nine inches from the end, black and smooth as a hand, wrapped around a limb, while other males, females, and young sat beneath him in a variety of positions. All at once the old fellow would set up a horrible rattling "Rochu, rochu!" which, after five or six repetitions, passed into a bellowing in which all the others would join, and which was loud enough to make one afraid of losing his hearing. It is so loud that it can be heard on still nights two leagues off; and it lasts for about ten minutes, and then subsides. The roar of the tigers, which troubled Pichegru and his companions so much on their flight from Cayenne to Surinam, was evidently nothing else than the howling of these apes, which might well fill one, hearing it for the first time, and not knowing that it came from harmless monkeys, with fright. The howling ape is sluggish and melancholy, and jumps only when it is pursued, while at other times it climbs deliberately among the trees, always holding itself by the tail. When captured young it becomes tame and confiding, and will play with cats and dogs, but is usually quiet, and if the person to whom it is attached goes away, it indulges in a continual rattling and highly unpleasant cry.

I could never succeed in raising one of them. They have a peculiarly unpleasant odor, by which one can easily tell when he is near one. Like all the apes, they bring only one young into the world at a time. Their principal enemy is the tufted eagle (*Falco destructor*).

The *quatta* (*Ateles paniscus*) is as large as the howling ape, but slimmer and not so slow. It does not appear on the coast, but only in the higher lands, where it constitutes a choice game for the bush negroes. Its head, body, tail, and feet are clothed in bright black hairs, while its nearly bare, narrow, ruddy face is very like that of an old Indian woman. The tail, about three feet long, is, like the tail of the alouatte, bare on the under side for about nine inches. The tip of the tail is also the animal's most delicate organ of feeling, and commonly answers to it the purpose of a hand. Wherever the monkey goes or climbs, that member is its support and its aid in climbing. If these apes are observed climbing, it is hard to tell what is tail and what foot; and they have been very aptly called spider-apes, because when they are hanging in the limbs they look like a big spider. They become very tame, but are much less lively and charming than the capuchin apes. They live on plants alone, and eat buds very readily, but never insects. While of the howling apes mostly males are shot, among the quattas the females appear to be more numerous. Their tails being tightly wrapped around the limbs, they do not fall from the trees when shot, but hang to them, sometimes till putrefaction sets in. For this reason the Indians of the interior shoot them with arrows that have been poisoned with the *woura*, the effect of which is to relax or paralyze the muscles, and insure a speedy fall of the animal.

The most docile of all the apes of Guiana, and the one that is most frequently taken to Europe, is the capuchin ape (*Cebus appella*). It is called *kesi-kesi* in Surinam, *macaque* in Cayenne, *meku* by the Caribs, and *pfuiti* by the Arowaks. It appears in pairs, or in troops of not more than thirty individuals, among whom are always some old males, with hair standing out from their foreheads, as if the animals had little horns. Their color is a dark olive-brown, a little lighter in the face. Their hands, feet, and hairy, winding tail are nearly black. They are about the size of a cat. They are very shy, and take quickly to flight whenever they perceive anything wrong. They have a peculiar flute-like call and whimper, which the Indians, having learned to imitate very deceptively, make a means of decoying them to be shot. They can often be heard in the woods, beating down nuts or conversing with one another. They live on fruit, birds' eggs, and perhaps young birds, too, but do not eat leaves or insects. If caught young they soon become tame, are very interesting, and attach themselves to those who treat them well, with a patient affection which they manifest by caresses and tears. They are very fond of tobacco-smoke, and take great delight in rubbing their bodies with "the weed." There are several varieties of the capuchin ape. A light-colored, very docile kind (*Cebus fatuellus*) is more abundant in the interior of the country. There are more males than females in this species.

The *Pithecia Satanas*, a handsome ape, living only in the mountainous interior, resembles the former species in figure, but is somewhat smaller, and has a bushy tail which hangs straight down. The Indians call it *hiu*. It is rare, and I only knew of one specimen that lived for a few years in a tamed condition. Its back is yellowish brown, its face black, and its head, feet, and tail dark brown. It lives in small families of five or six individuals, and is not very active or hard to catch. I had a young female on the Maroni, but it soon died. I also had a male that had been shot and had recovered, but it never became tame, and died on board the vessel that was taking it to Amsterdam.

The remarkable feature of this ape is its beautiful hair and beard. The dense head-hair of the male is divided in the middle of the forehead into a thick beard about two inches long, running down the cheeks and under the chin from one ear to the other. No beau could keep his beard and hair in better order than this handsome animal.

The prettiest of the apes of Surinam is the squirrel-ape (*Chrysobryx sciurea*). It is called the monkey in the colony, *sapajou* in Cayenne, *akalima* by the Caribs, and *cabreanama* by the Arowaks. I kept three of these little monkeys at a time for twenty-six years; and as soon as one died, I took care that another should come in its place. One of them lived thirteen years in captivity. They are considerably larger than a squirrel; the body is about twelve inches long, colored greenish-gray with a white belly; the fore and hind legs are golden yellow, face and ears white, snout black, and eyes large and brown. The hairy, soft tail is black at the tip and a little longer than the body, and serves the animal as a kind of balancing-pole when he takes his jumps. In sleep and at rest the tail is slung over the shoulders. These apes are very lively, always in motion, although they sleep through the day, and are extremely sensitive to cold. They lie much in the sun; and, if one would have them live in Europe, they must be kept constantly in a temperature of not less than 75°. They usually live in large troops of a hundred and more, not in the deep woods, but in the shrubbery on the borders of the woods, and support themselves on fruits, insects, and birds' eggs. I always got them quite young, and they soon accustomed themselves to milk, bread, and ripe bananas, on which they thrived well. When at first they were allowed to run around loose in the room, they would suck their thumbs like a child for hours at a time. Their clean, white faces, with the hair-line sharply defined, their black mouths, large, lively eyes, and their sprightly, confident behavior gained them everybody's liking. Although they were easily enraged, they would soon return to a good humor; and in most ways they behaved very much like little children. They never tried to bite unless they were irritated, and under good treatment were as harmless, pleasant creatures as one could find. They were kept tied under the galleries of my house, and at night were shut up in a kennel together, for they could not be allowed to run about in the house after they grew up, because they handled and spoiled everything. If they were allowed to run at large, they would attach themselves to the swine, and run around with them through the meadows. At five o'clock every evening, after the shutters had been closed, they were let loose, and had a mad chase among the bread-fruit and palm trees, which lasted till it grew dark, when they came of themselves to be shut up in their kennel. While they ate insects, they did not seem to know how to distinguish the poisonous ones; and three of them died from eating the wrong butterflies. We were indebted to these little animals for much entertainment in our solitude on the Maroni.

These apes are not docile, and, notwithstanding their comparatively large foreheads, they are far beneath the capuchin apes in intelligence. When they feel well, they purr like a cat; when frightened, they utter a sharp, shrill, palatal sound; if angry, they scream like a magpie. They were usually brought to me from the sea-shore, where they used to sport in the most lively manner among the awarra palms, never seeming to mind the long, sharp thorns with which these trees are covered. The Indians shoot the mothers while they are carrying the young on their backs, or else they shake the young from the trees after the mothers have set them down. Males are rarely taken, but nearly all that are caught are females.

I had at several times specimens of another pretty ape, the *manaku* (*Pithecia leucocephala*), called by the French *maman dinan*, and *arighi* by the Caribs. It is not larger than the squirrel-ape, but seems to be twice as thick, on account of its long hair. The male is dark-gray and covered with long hair, with a hairy and bushy tail about ten inches long. The light-yellowish, hairy face looks like a mask, beneath which the black nose and the mouth are strongly marked. The female is brownish. This monkey is easily tamed, but is always shy and melancholy. It lives in troops of not more than ten members, in the deep woods. It is quite rare.

These eight monkeys are the only species that live in Dutch Guiana, no others being known, even to the Indians. Such broad streams as the Amazon, Orinoco, and Rio Negro seem to make a separation between species, so that mammalia, even when the plant-life is alike on both sides, are wanting on one side of the waters while they are common on the other side.—*Translated for the Popular Science Monthly from Das Ausland.*

SKETCH OF CLEVELAND ABBE.

THE name of Cleveland Abbe is especially associated with the installation of the meteorological service and weather forecasts of the United States Signal Service, and he has been prominently active in the movement to establish a uniform standard of time for the American continent, which should also be in conformity with the standards of other nations.

Professor ABBE was born in New York city, December 3, 1838. He is a son of the late George Waldo Abbe, who was for many years prominent in the business life of New York, and closely identified with its principal charitable organizations. He received his academical education at the New York Free Academy, now College of the City of New York, where he made a most honorable record for diligence and fidelity in his studies, or to use the words of one of his classmates, as "a young man who was interested in his work, and anxious to learn.

As he went through college his ability in mathematical and mathematico-physical science became more and more apparent, and, at the close of the college course, there could be no question of his superiority." Having been graduated from this institution in 1857, he taught mathematics in Trinity Latin School for one year, and afterward connected himself with the University of Michigan, where he served as teacher of the higher mathematics in the Scientific School, and studied astronomy under Professor Brünnow. Thence he removed, in 1860, to Cambridge, Massachusetts, where he spent four years in association with Dr. B. A. Gould, and was engaged upon the telegraphic longitude work of the United States Coast Survey. In continuance of his astronomical work, he resided for the two years, 1865–'66, at the Observatory of Poulkova, in Russia, which was then under the direction of the illustrious Otto Struve, in the position of supernumerary astronomer, as those young persons not military officers are called, who are allowed by the statutes of the institution to reside within its precincts for their own advantage. Generally, according to Mr. Abbe's account of the observatories at "Dorpat and Poulkova," which is given in the report of the Smithsonian Institution for 1867, "these inevitably contribute something to the furtherance of the scientific work of the observatory, while receiving from it the treatment of guests. The new statutes allow the director to give these young men a position and rank as civilians serving the observatory, but not in the service of the state ; thus they may be properly considered as supernumerary astronomers, who, however, enjoy some of the privileges of such as are permanently in the state service, which is no mean advantage in the autocratic Russian Empire. Although these are at liberty to devote their whole time to their own studies, they yet generally choose to contribute several hours daily to the regular work of the observatory, receiving a small compensation therefor." Returning to the United States, he became connected, in 1867, with the National Observatory at Washington ; but he had not resided there long before, on the 1st of February, 1867, he accepted the position of director of the Cincinnati Observatory, and he removed there on the 1st of June. This institution, which had been founded through the exertions of Professor O. M. Mitchell, and the corner-stone of which was laid with accompaniment of great public interest by John Quincy Adams, in 1843, had never been adequately supported, and had been virtually suspended for the past half dozen years. Preparatory to taking charge of it, Mr. Abbe visited the other observatories and astronomers of the country, and found everywhere the heartiest pleasure exhibited at the intended resuscitation of the institution. "Each," he says, "seemed to seek to find some way in which to offer assistance and encouragement, while all united in deploring the inaction of the past ten years. There is, in astronomy, a continual endeavor on the part of each one to add something to our knowledge by his own original observations and researches; nor does any one feel that he has attained to any degree of usefulness until this has been accomplished; accordingly, all unite in expressing the hope that we shall now push on in the field of astronomical activity." Encouraged by such expressions, he declared as the sentiment that should actuate the future course of the institution, that "the pursuit of abstruse astronomical investigations, and the utilization of practical astronomy are equally important to the true interests of the observatory, and should be simultaneously cultivated."

In the more detailed plan for the future activity of the observatory which he outlined in his inaugural report, Professor Abbe gave a prominent place to the particular subjects, in connection with which he has won fame. It was his desire, primarily, to extend the field of activity so as to embrace, on the one hand, scientific astronomy, meteorology, and magnetism, and, on the other, the application of these sciences to geography and geodesy, to storm predictions, and to the wants of the citizen and the land-surveyor. In meteorology, he remarked, the observatory ought to keep record of regular hourly observations of all phenomena depending upon observations of the atmosphere: "The science of meteorology is slowly advancing to that point at which it will begin to yield most valuable results to the general community. Although we can not yet predict the weather for a week in advance, yet we are safe in saying that, with a proper arrangement of outposts, we can generally predict three days in advance any extended storm, and six hours in advance any violent hurricane. This may be effected simply by constituting the observatory a central station, to which telegraphic reports of the weather are regularly daily transmitted. The careful study of these dispatches enables the meteorologist safely to make the predictions mentioned, which can be at once disseminated through the public papers or otherwise. In France, Italy, and England, and on our own eastern coast, such storm-warnings are considered of very great importance." The co-operation of the Smithsonian observers and those of the army had already been promised; and at the end of the year, in consideration of the fact that the most of our storms appear on this side of the Rocky Mountains and move eastward, observers had been secured at Omaha, Cheyenne, Sherman, and Salt Lake City. It would also be one of his objects to secure and supply more accurate determinations of time, and for this purpose the observatory would furnish the hour regularly to all the watchmakers who would apply for it; an offer was also made to the municipal government to furnish it to the city.

The location of the observatory in the smoke-saturated atmosphere of Cincinnati had been for some time recognized as unfavorable, and efforts were making to secure a more suitable position for it. While this was going on there could be but little heart in such measures as might be proposed for permanent improvements in the building or the fixed apparatus. It therefore seemed evident that the remaining time spent upon Mount Adams could be best improved by paying special attention to meteorology. An hourly record was begun of all important atmospheric phenomena. Monthly reports of meteorological observations were received from observers in other cities. The interest of the Chamber of Commerce was engaged in the organization of a system of daily weather-reports and storm-predictions; the gratuitous co-operation of experienced observers was tendered; and the use of the Western Union telegraph lines was offered at a nominal price. The daily "Weather Bulletin" of the Cincinnati Observatory was issued, first in manuscript form, for the use of the Chamber of Commerce, and a week later in print, as an independent publication. It was supported for three months by the Chamber of Commerce, then passed into the hands of the observatory. Finally, the independent publication was discontinued, and the bulletin only appeared under the same title in the morning papers. Subsequently, the publication, by a manifold process, of a daily weather-chart was undertaken, which, in consequence of the observatory's lack of means, was kept up at the expense of the Cincinnati office of the Western Union Telegraph Company. The National Board of Trade meeting at Richmond, Virginia, united in a memorial to Congress, the fruit of which, with other proceedings of a similar character, among which was Professor Lapham's memorial asking for the institution of signals for Milwaukee and Lake Michigan, was the passage of a joint resolution authorizing the Secretary of War to provide for taking meteorological observations at military posts in the interior of the continent, and on the lakes and sea-coasts, for the purpose of giving warning of the approach and probable force of storms.

The superintendency of these observations, or the "Weather Bureau," was put in the charge of General Albert J. Myer, Chief of the Army Signal Service, who appointed Professor Abbe his assistant, or meteorologist. In this position, Professor Abbe, during 1871, organized the methods and work of the so-called "probability" or study-room, in making weather-maps, drawing isobars, ordering storm-signals, etc., and dictated the published official tri-daily synopses and "probabilities" of the weather. In the same year he began and urged the collection of lines of leveling, and in 1872, by laborious analysis, deduced the altitudes of the Signal-Service barometers above sea-level. He instituted in 1872, and reorganized in 1874, the work of publishing a monthly weather-review, with its maps and studies of storms. He urged the extension of simultaneous observations throughout the world, as the only proper method of studying the weather; and, as General Myer distinctly avowed, the success of the negotiations of the Vienna Congress of 1874 was due to following his advice. And he organized, in 1875, the work of preparing the material and publishing the "Daily Bulletin of Simultaneous International Meteorological Observations." Especially is the organization of the numerous State weather services of the country due to his advocacy, and to the letters sent by his advice by General Hazen to the Governors of the States.

Professor Abbe's unselfish devotion to the pursuit of science for its advancement and not for his own, has prevented his name from appearing as prominently in connection with the work of the Weather Bureau as it deserved to do ; but there is a general concurrence of testimony that he has been its guiding spirit. A gentleman, whose special researches in co-operation with it, have given him a world-wide reputation, characterizes him in a note to us as an enthusiastic meteorologist, whose whole soul and energies "seem to have been given to the furtherance and interests of the service. He kept well read up on all meteorological matters, and had a very high appreciation of much that he read ; and, when this was the case, he was always very desirous of bringing the matter and the author into notice by means of translations and republications. In fact, he seemed to me to be more desirous of bringing the works and the claims of others into notice than his own. His notes on meteorological subjects, published in the Smithsonian Reports, sprung from his extensive reading and desire to communicate to the public whatever he found of value in the course of his reading. These notes have been very valuable in keeping before the mind the principal results obtained in various ways in the progress of meteorological discovery. Being virtually the scientific adviser of the Signal Service, and having control mostly of its scientific work, on account of his generous and unselfish nature he was not content to occupy the field of scientific work alone, but when General Hazen was put at the head of the service and a more liberal policy toward civilians and in the encouragement of scientific work was adopted, he seemed to wish that all the leading meteorologists of the country could have a part in what he considered the great work of the country, and he especially interested himself in endeavoring to give a chance to promising young men of the country to have a part in this work."

Another gentleman, of world-wide eminence in physical investigation, writes to us : "I will merely state what will, I think, be generally admitted by all competent to express an opinion, that for the good work done by the United States Weather Service, and for the high estimation in which it has been held by Europeans generally, the country is indebted to Professor Abbe more than to any other one man. He was unquestionably the first to put into actual operation the scheme of telegraphic weather-warnings, and thus to realize the suggestions and hopes of Professor Henry in that direction. This he did at Cincinnati, Ohio, before the organization of the United States Weather Service. . . . It was his success in this preliminary work at Cincinnati which led to his being called into the service almost immediately after the organization of the Weather Bureau as a branch of the Signal Service of the United States Army. His relations to this service have always been in some degree anomalous and yet of the very highest importance. . . .

In the beginning he was the one man in the service who knew much of meteorology, and from that time to the present he has been conspicuously the representative of that science in Government employ. The constant change in the *personnel* of a bureau of the army, the continued coming in of this officer and the going out of that, is one of the serious obstacles in the way of the successful cultivation of a science, either pure or applied, under a military *régime*. The weather service has been preserved from stagnation and decay by the continued presence of such an ardent student as Professor Abbe. On all important questions touching the scientific work of the service, his advice has been sought by the Chief Signal Officer; most plans for its improvement and extension have originated with him, and he has done much to stimulate the study of meteorology outside of the service as well as within it."

We are informed by Mrs. Hazen, widow of the late Chief of the Signal Office, that Professor Abbe was always held in high esteem by her husband, "and relied on not only as a very scientific man, but as a loyal friend." This sentence brings out another salient trait in his character—his loyalty to his chief. Readers of the "Monthly" will recollect the tribute which he improved the first opportunity after General Hazen's death to pay to his character and the worth of his work for science ; but they do not know, for that is matter of personal confidence, that he was extremely anxious that General Hazen should receive full credit for all that he did, all that he helped to do, and all that he was in any way the means of having done for science ; and particularly that he should be vindicated from the unfriendly criticisms which the newspapers had cast against him—all of which Professor Abbe believed to be unjust and unfounded.

Professor Abbe's efforts, while engaged at the Cincinnati Observatory, to furnish accurate time to the watchmakers and the public clocks of the city have already been mentioned. This service he regarded as always a daily duty in a well-organized observatory. Similar work was already performed by a number of observatories in America and Europe, one of the earliest instances of it being the giving of the time to the city and province of the Magnetic Observatory at Toronto in 1842. The British Astronomer Royal began the dropping of the noon time-ball at Deal in 1852, and was followed by the United States Naval Observatory at Washington in 1855. An automatic apparatus for controlling the public clock from the observatory was ordered in Cincinnati in 1870. Afterward the Pennsylvania Railroad Company intrusted its time-signals to the Allegheny Observatory, under Langley. In 1877 an arrangement was made between the Naval Observatory and the Western Union Telegraph Company for delivering time-signals at important places in the United States.

The inconveniences arising from the ever-varying standards of local time, which required a change of the watch for every few miles of traveling east or west, had attracted an increasing attention for many years, and had been the subject of earnest discussion by the general time conventions of the railroad officials. The matter was also taken up by Professor Dowd in 1870, and was agitated by the American Metrological Society, which at Abbe's suggestion appointed a special committee on the subject, the American Society of Civil Engineers, and the American Association for the Advancement of Science. Professor Abbe, Dr. F. A. P. Barnard, Mr. E. B. Elliott, and Mr. W. F. Allen were among the earliest, and were at all times the most active and efficient, advocates of a reform in this matter in the United States. The most practicable way to secure a reform seemed to be to induce the railroads of the country, which were shown to be using no less than seventy-five different standards in regulating the movements of their trains, to accept some uniform system. Hitherto it had appeared impossible to agree upon any plan which they would recognize as practicable. Some persons advised a uniform standard for the whole country, such as the time of the seventy-fifth meridan (nearly Washington time) or of the ninetieth meridian, while others proposed the "hour difference" plan. Professor Abbe was the chairman of the committee on the subject of the American Metrological Society, and in 1879 presented a report in which the whole question was carefully reviewed. This report embodied a number of resolutions, advising the discontinuance of the use of local times and the adoption instead of the standards of the principal railroads in their respective localities; and suggesting to railroad officers a reduction of their time-standards to one for every hour of longitude. But while the adoption of a few standard meridians was regarded as an improvement, which could be no inconvenience, but would tend to diminish inconveniences already almost intolerable, the committee could "but look upon it as only a step forward by the community at large toward that absolute uniformity of all time-pieces, that is, we think, already practicable on the part of railroad and telegraph companies." The adoption of an absolute uniformity of time throughout the whole country was therefore urged upon those companies and all kindred associations, and the time of a meridian six hours west of Greenwich, or the ninetieth meridian, was recommended as such ultimate common standard. The adoption of the reform thus indicated would, the committee believed, materially help toward the adoption of a uniform standard throughout the world. This standard, it was suggested, could most conveniently conform to the meridian one hundred and eighty degrees from Greenwich. Nevertheless, this question was regarded as one for the distant future, to be considered in some international convention. "This report," says Professor Dowd, in relating the part which he had taken in the movement, "is specially worthy of mention, as it seemed to present the first plan, other than the one forming the subject of this paper, for systematizing the time-standards of the country. Although the report centered upon one time-standard for the country—the plan upon which I started and which I had felt obliged to abandon—yet it grouped together so much practical information, and was so suggestive of new lines of thinking, that it really marked a new era in the history." Professor Abbe presented another very important report to the Metrological Society at the December meeting of 1880. President Barnard was appointed to draw up a circular upon the subject, and send it out to all who might have an interest in the matter; and with the help of Mr. Allen, of the Railway Time Convention, the plan of hourly-standards, which is now in use, was prepared, and the co-operation of nearly all the important railroads secured for its successful introduction.

As the delegate of the United States to the International Meridian and Time Conference, which met at Washington in October, 1884, Professor Abbe presented an argument which had considerable weight in deciding the questions at issue, although it was only circulated in proof-sheets among the members, and was withheld from publication because if it became official it would necessitate a long reply from the French delegates, and prolong a discussion that was likely to be unnecessarily tedious. In this paper he offered as a solution of the question of the real neutrality of the prime meridian, which the French delegates insisted upon, the proposition that "the prime meridian shall be defined by references as exact as may be practicable to all the national astronomical observatories of the twenty-five nations represented in this conference; the grounds belonging to these observatories shall be declared neutral territory, and the astronomers in charge shall be respected in all international matters; the precise choice of the prime meridian shall be based on the principle of doing the least possible violence to the existing customs of the world consistent with the attainment of the greatest possible good; that when adopted this meridian shall receive no national designation obnoxious to any people, but the whole system shall be known as the International Prime Meridian, International Longitude, International Time."

Professor Abbe led the party which went out from the Cincinnati Observatory to observe the total eclipse of August 7, 1869. The company traveled in wagons from Sioux City to the line of totality near Sioux Falls. His own attention was devoted to the observation, under high power and in a small field of view, of three conical protuberances of peculiar character, and he missed the coronal streamers which were observed by the others with the naked eye and with opera-glasses; and he doubted whether the latter were not individual and subjective phenomena, or originating in the earth's atmosphere.

At the eclipse of August, 1878, he selected a station on the summit of Pike's Peak, but was taken ill there, and had to be removed to the Lake House (elevation ten thousand feet). Having recovered to a sufficient extent, he was laid upon the ground during the eclipse and devoted himself wholly to the study of the rays that extended above the brilliant ring which was presumed to represent the true solar atmosphere. On this occasion, these rays revealed themselves so distinctly and brightly, and shone with such steady light, that he could no longer doubt the accuracy of the accounts of his fellow-observers of the eclipse of 1869, nor that the phenomena were independent of personal equations and atmospheric effects. He explained them as being due to reflection from the streams of meteor-dust which are supposed to be constantly flowing toward and around the sun.

The list of Professor Abbe's published papers down to 1880 includes eighty-four titles, several of which cover more than one article. The papers relate chiefly to subjects in astronomy and meteorology, and to matters connected with the author's particular work. They include reports and other articles of a documentary character, seventeen articles in "Appletons' Cyclopædia," nine in Johnson's, contributions to Baird's "Annual Record of Science and Industry," articles in scientific periodicals, and articles in newspapers—all tending directly to the increase or diffusion of knowledge. Professor Abbe has been engaged for many years in the supervision of a bibliography, which is now near completion; and has completed a treatise on meteorological instruments that will soon be published by the Signal Office.

Some of Professor Abbe's personal qualities have already appeared incidentally in the regular course of this sketch. The key to them appears to be unselfishness—a virtue which has been prominently manifested through the whole of his life. His classmate, already quoted from, writes: "Everybody liked Cleveland Abbe thirty years ago, as I suppose everybody likes him now. He was unselfish, modest, kindly then, and, in disposition, though only twenty years old, a scientific man, a lover of scientific truth." A scientific friend, whom also we quoted before, corroborates this, saying: "In disposition, he is unselfish to a rare degree, generally managing that others shall get the credit for work in which he has had a large share. To this characteristic, together with the somewhat peculiar code of ethics which prevails in the Government service, must be attributed the fact that his contributions to the science of meteorology have appeared less frequently than was hoped for by some of his friends."

His policy in connection with the Signal Service is eloquently described in a letter of January 28, 1886, presented by General W. B. Hazen to the Joint Committee of Congress on the Signal Service, and printed in the bulky volume of testimony, where he says, page 1057, "Until finally accepting the inevitable, he announced it as his own established policy, on the one hand, to himself prepare little or nothing for publication of an original nature; and, on the other hand, to advise, assist, and stimulate the work of every member of the service to the very best of his ability." This policy is now ended by the special orders of Generals Hazen and Greely, who have directed that his time shall be mainly given to those greater works that the world has a right to expect from his knowledge and experience.

EDITOR'S TABLE.

INTERNATIONAL COPYRIGHT.

THE latest scheme for an international copyright combining some of the more prominent provisions of earlier plans with a new feature of his own, is offered by Mr. R. Pearsall Smith of Philadelphia, and printed in a recent number of the "Nineteenth Century." The comments on the plan of a dozen distinguished Englishmen accompany the article, the publication of which, whatever the fate of the proposal, has served at least one good purpose. By renewing attention to the subject it has set people thinking and provoked discussion, and in a case fraught with such rank injustice to our home as well as to foreign authors, every general stirring up of the question must do good. It will help to quicken the moral sense of the community, and perhaps in time will make it lively enough to force Congress into the performance of what all right-thinking persons are agreed is a clear national duty.

Of the plan itself, however, as a practical working solution of the difficulty, little that is favorable can be said or expected. Accustomed, through the piratical practices of former years, to an abundant supply of low-priced literature, American readers will not, it is claimed, consent to a monopoly copyright on foreign books, or, put in another form, they will continue to deny to the property rights of the foreign author that reasonable measure of protection which is now freely accorded to the rights of our authors at home.

The reasons assigned for their persistence in this palpably unfair discrimination are, in substance, that such a law would mean English prices for foreign books in this country; it would cause a great diminution in the volume of our literature; cheap editions would disappear from the market, and the publisher would be enriched at the expense of the reader, without any corresponding benefit to the author.

To avoid this imaginary revolution in the literary affairs of the United States, and at the same time secure to the foreign author his dues, the scheme in question proposes to give to any one in this country the privilege of publishing in any style and at any price he sees fit, any foreign book he may select, on condition that he *first* pay to the author a royalty of ten per cent on the retail price of each copy of the work he *expects* to sell. The evidence of his compliance with this requirement is obtained in the form of stamps, which the author is obliged to furnish to every applicant, or as a penalty for refusal suffer the loss of all his American rights. A single stamp is to be affixed to each copy of the book before it leaves the publisher's hands; and is thus expected to serve as a check on possible attempts to dispose of unauthorized editions.

To illustrate the way in which an arrangement of this kind would be likely to work in practice, we will suppose that some spirited author ventures upon a choice of publishers, and finding one who is bold enough to negotiate, he bargains to have his book brought out in a style suited to the subject, to his own reputation, and to the class of readers he is expecting to reach, trusting the result to the joint interest of his publisher in the enterprise. The next week, six months, or perhaps a year later, as the case may be, he is compelled under the new law to mercilessly cut the throat of his business associate, wiping out his property, and destroying his market, in the interest of another publisher, who, shrewd enough to see his opportunity and having the game in his own hands, demands the stamps for an inferior and low-priced edition. Under such a condition of things, publishers of ordinary business sagacity would be slow to assume even the smallest risk, the utter insecurity of the property making all business enterprise in that direction precarious. In this connection, we can not do better than to give the views of Mr. W. H. Appleton, whose long experience as a publisher enables him to speak with an authority which greatly outweighs the untried speculations of one who, like the writer in the "Nineteenth Century," has no practical knowledge of the business. Referring, in 1872, to a proposed international copyright law that was then under discussion, and which, like the present plan, provided for open competition in the reprinting of foreign books, Mr. Appleton said:

> The first demand of property is for security, . . . and to publish a book in any real sense—that is, not merely to print it, but to make it well and widely known, requires much effort and larger expenditure, and these will not be invested in a property which is liable to be destroyed at any moment. . . . The publisher can neither afford to make the book so thoroughly known, nor can he put it at so low a price as if he could count upon a permanent and undisturbed control of its sales. Many valuable books are not reprinted at all, and therefore are to be had only at English prices, for the same reason that publishers are cautious about risking their capital in unprotected property.

In its other business aspects, such as the opportunities it affords for fraud, the possible difficulties in recovering the value of unused stamps, and the general influence on the trade of the uncertainties of open competition, the plan is equally objectionable. Indeed, taken as a whole, it seems much better adapted to the purpose of quieting our consciences while we hang on to the plunder, than to the furtherance of its ostensible object—the benefit of the British author.

The fact is that the assumption on which the whole scheme is based, viz., that American readers will not accept a monopoly copyright on foreign books, is untenable, and is, in the opinion of many, squarely contradicted by the facts. For three quarters of a century Americans have bought books at fair prices under monopoly copyright without finding fault, and, moreover, when the demand arose, have enjoyed the advantage of lower-priced editions However it may be slurred or ignored, the truth is that the American people have had a great deal less to do with this denial of justice to English authors than the publishers and the politicians; and when some member of Congress, in pursuit of a little cheap political capital, sets up the plea that his constituents are not willing to pay fair prices for the foreign author's property in this country, he may very reasonably be asked to back up his statements with some unmistakable expressions of feeling from the people themselves. That American readers have accepted and upheld a monopoly copyright at home may, until we have something definite to the contrary, fairly be taken as an indication that, when made acquainted with the true bearings of the case, they will be equally fair toward the interests of the foreign author. As a matter of fact they have already given abundant evidence of this kindly feeling in the purchase of substantial editions of English and other foreign reprinted books of a solid character, amounting in the aggregate to hundreds of thousands of volumes, paying prices therefor which have enabled the few high-minded publishers who voluntarily entered into the arrangement to hand to the foreign author exactly the same return that he would have received if a citizen of this country. The publishers following this practice have been able to make and sell these books at American prices, and have also found their profit, when the demand would justify the venture, in the sale of cheap editions. Of course, in doing this they exposed themselves to serious risks, and but for the old-time courtesy of the trade, by which they were to a considerable extent protected, it would have been impossible; and the fact that with the recent enormous development of piracy, which respects nobody's rights of property, they have suffered material losses, is but a confirmation of the point that the open competition proposed in the present plan would have exactly the same effect that piracy is having now.

In fact, then, we have a practice which has grown up under existing conditions that makes no distinction between our authors and those of other countries, which is supported by a large class of readers, and which only needs the simplest legal sanction to completely solve the question of international copyright without resort to untried, complicated, and otherwise doubtful business methods.

Looked at from the moral side, which really is the only proper stand-point, Mr. Smith's plan is, if possible, open to still stronger objection, and its defects in this respect are so cleverly and forcibly pointed out by Professor Huxley in the "Nineteenth Century" that we make no apology for quoting his remarks in full. He says:

I find in Mr. Pearsall Smith's interesting paper two chief matters for consideration: the one is a statement of the moral principles by which the transatlantic English-speaking people propose to govern themselves in dealing with the property of British authors; and the other is a plan for securing to the said British authors such a price for the use of their property as is compatible with the moral principles in question. The principles are very easily gathered from Mr. Pearsall Smith's candid exposition of them. Transatlantic readers, it appears, by no means go so far as to deny that a book is the property of its author; and they are evidently quite shocked at the notion that, when they possess themselves of a pirated edition, they may be placing themselves in the position of receivers of stolen goods. Their conscience has been stirred to its depths by the suspicion that such may be the case, and will give them no peace until they are satisfied that the man whose genius has charmed away their sorrows or opened up new vistas for their intellect has not been left to starve on mere praise. All they ask (and they seem to think the request a grace) is that they themselves shall be the assessors of the pecuniary value of their obligations. "Our souls require moral and intellectual elevation; we are accustomed to get these elevators cheaply, and we mean to go on getting them cheaply. We shall be happy to consider any arrangement for rewarding the makers of the elevators consistently with that declaration; but they had better recollect that we are masters of the situation, and that we shall appropriate our spiritual nourishment without payment, if we can not get it at our own price."

In England we still retain so much of the ingrained conservatism of the decaying civilizations of Europe, that, if a starving man goes into a baker's shop, and carries off a sixpenny loaf, leaving only twopence in its place, the poor wretch is haled before the nearest magistrate and sent to prison for a thief. It would be no good whatever for him to plead that his bodily frame absolutely required to be elevated and kept erect by regular installments of bread; that he had been accustomed all his life to get a big loaf for twopence; and that, in his judgment, the baker got quite enough profit out of the twopence—to prison he would go. But see the difference. The starveling is not (at any rate yet) master of the situation, and the baker (*plus* the magistrate) is. However, we are altering all these things rapidly. It has become an axiom among a large and influential class of our politicians, that a want constitutes a good claim for that which you want, but which other people happen to possess. The "earth hunger" of the many has established itself as an excellent plea for the spoliation of the land-owning few; lease-holders are already trying the effect of "house-hunger" on house-owners; and the happy time seems approaching when the consumer, and not the producer, will fix the price of all things desirable. The course of action by which, according to Mr. Pearsall Smith, transatlantic readers propose to deal with British authors, is but another anticipation of that social millennium when the "have-nots," whether they lack land or house or money or capacity or morals, will have parted among themselves all the belongings of the "haves"—save the two last mentioned.

The proposed plan for "protected copyright with free-trade competition" has one merit. It recognizes the right of property of an author in his work. It is a frank confession that piracy is theft. But, as a practical measure, I can not say I feel any confidence in its working. The author is to provide stamps for each copy of his work, and anybody who chooses to publish it is to obtain the number of stamps required for his edition, on paying ten per cent of the publishing price to the author or his representatives. It appears to me that there are serious—not to say fatal—objections to this project from the point of view both of the author and of the publisher.

From that of the author, because unless the stamps are executed with the care and cost of a bank-note, they may be counterfeited with the most tempting eagerness. Suppose that I had the good fortune to be the author of a popular novel, and that I found that some scamp of a bookseller was issuing an edition with forged stamps at Chicago, and another playing the same game at Toronto. Unless I happened to have a few thousands of which I desired to make ducks and drakes, is it conceivable that I should be so foolish as to take action against my defrauders in the civil courts of these two cities, when, in all probability, the judge would have a copy of the pirated edition in his pocket, while bar and jury were equally well provided? How shall Angelo condemn Claudio without many qualms? Suppose I succeeded and obtained the award of five times the retail price of the cheap edition—which is the maximum fine proposed—to what extent would that recoup me for law expenses, worry, and loss of time? Legal administration is comparatively cheap and swift in Scotland; but an eminent Scotch judge once told me that if he were riding along Leith Walk, and somebody preferred a claim to his horse and took it away, he should think it, on the whole, better to put up with the loss of the horse, than to go to law with the spoliator. Certainly it would be better for the English author to sell all he had and give it to the poor, than to undertake a copyright process in the United States or Canada in the face of the existing feeling that "our people" have a right to "nourish themselves and their children," as Sir C. Trevelyan put it, on cheap books. The former process, at any rate, would not leave him in debt.

And now as to the position of the publisher under the proposed arrangement. My experience of publishers, both in England and America, has been such as to lead me to differ somewhat from the estimate which many of my brethren seem to form of them. So far as my observation has gone, they have as much claim to the possession of souls as other people; and I have not been able to convince myself that the portion of inherited depravity in the average publisher is greater than that implanted in the average author. I have frequently asked myself whether, for any possible benefit which my publishers get out of my books, I would or could submit to the worry, loss of time, and pecuniary risk of bringing them out on my own account; and I have had no difficulty in answering this question in the negative. But there are publishers and publishers, and there are various fashions of bringing out books.

As our transatlantic readers admit that an author has some right of property in his work, I am a little perplexed to understand why they deny his right to appoint the agent * on to whose shoulders he desires to throw all the burden and risk of giving that work a practical existence, and to decide in accordance with him the form of their joint produce and the remuneration they may ask for it. The farmer, the miller, and the baker decide the price at which they can afford that the loaf which they have jointly produced shall be sold. In revolutionary times, starving mobs, desiring to have the sixpenny loaf for twopence, call the baker a monopolist, and proceed to hang him *à la lanterne.* The transatlantic people, impelled, as it appears, by their spiritual cravings after the intellectual and moral elevation imparted by the works of English authors, call the publisher, who stands in the same relation to the author as the baker to the farmer, a "monopolist." Heaven forbid that I should suggest that my excellent friends, the Messrs. Appleton, may stand in danger now or hereafter of the *lanterne.* Not at all! The sixpenny loaf can be got not merely for twopence, but for nothing, without any such violence, by simply continuing the present practice of piracy, checked only by the underselling power of the strong houses.

Grant, however, that the appointment by the man who possesses a property of an agent to administer that property, according to such terms as they may mutually agree to, is an offensive act of monoply on the part of the owner—what will be the practical working of the scheme which it is proposed to substitute for this old-world expression of rights of ownership?

I suppose myself an American or Canadian publisher. I hear that the celebrated English author A. B. is about to produce a work which is certain to be greatly in demand on my side of the Atlantic. As things are,

* I see no reason for demurring to the requirement that the agent should be a native of the country in which the sale is to take place, if, as is asserted, there are strong practical grounds of objection to any other arrangement.

if I bring out an edition of ten thousand, I, in the first place, risk the whole prime cost of that edition on the accuracy of my judgment of the public taste. To those who have had experience of the uncertainty of such judgments this will probably seem enough. But the new scheme proposes that I shall add to this risk the deposit, with the author or his representatives, of a sum equal to a thousand times the selling price of a single copy, with the prospect of a possible lawsuit against a man who is usually not rich, an indefinite time afterward, to get back the value of stamps for unsold copies in case I have made a mistake. And, for all this additional trouble, risk, and tying up of capital, I get absolutely nothing. It is open to my rival in the next street to write for the necessary stamps and undersell me whenever he pleases. For the publisher, therefore, the state of things would remain exactly as it is now—a condition of internecine warfare, in which only those houses can afford to pay copyright who are wealthy enough to break down any one who trenches on their ground. The relation of authors to publishers in America at present is exactly that of the traveling merchants to the barons of the middle ages. Put yourself in the hands of any one of them who was strong enough, and he protected you against all the rest; otherwise, you were every man's prey. I do not see how the projected scheme will alter this state of things. It is further to be considered that the new proposal leaves the author absolutely at the mercy of anybody who applies for stamps. The publisher may turn out an ill-printed, ill-corrected version (perhaps improved and amended to suit the taste of the transatlantic people), and the author has no remedy.

In the case of illustrated works the wrong may be still more gross. I speak with some knowledge of the cost and trouble of preparing illustrated scientific books. The author may spend months or years in dissecting and preparing the requisite objects and in making or superintending the execution, in the first place, of drawings from them, and, in the second place, of the engravings made from these drawings. It rarely happens that he obtains more than the most bare and scanty remuneration for the labor thus spent, which often is as great as that of writing his book. The work being published in England, an American publisher writes for stamps for an edition, say a third or a fourth of the price per copy of the English one. It is perfectly easy for him to do so; the paper and the mere type-setting after a printed book do not come to much, and the illustrations, which have cost the producer so much trouble, can be reproduced at a fraction of the cost of the originals. If they are coarse and clumsy, with references half wrong, what matter? The discredit is put down to the author's account.

In conclusion, I am of opinion that this proposal for "protected copyright with free-trade competition" is false in principle, and, so far as English authors and transatlantic publishers are concerned, would be futile in practice. If adopted, it will merely come to the issue of letters of marque to people who are now frankly pirates. The French valet said to the master who offered him so much a year if he would leave off the pickings and stealings, "Monsieur,' je préfère de vous voler." I may paraphrase the candid valet's confession, and declare that if I am to be robbed I prefer to be robbed openly.

If the transatlantic reader admits, as he professes to do, that an English author has rights of property in the book which he has written, he seems to me bound further to admit that the author may at least appoint an agent in the reader's own country with the exclusive right to make and sell the book under such conditions as that agent, knowing the wants and condition of the community, may think prudent and reasonable. If my transatlantic friend calls that proposal "undisguised monoply," I call any which offers less to the author more or less disguised piracy.

LITERARY NOTICES.

Our Heredity from God: Consisting of Lectures on Evolution. By E. P. Powell. New York: D. Appleton & Co. Pp. 416. Price, $1.75.

The author of this book is pastor, we presume, of a society in Utica, who, having been born and bred in Calvinism, experienced a shock, as he phrases it, "in the face of its dire failure to explain the universe, to apologize for God, or to save mankind." Having lost faith in authoritative revelation, he sought in the study of evolution deliverance from the chaotic condition in which his mind was left. The outcome of his struggles and the purpose of his book are expressed in his declarations that "earnest and honest men can not too soon comprehend that our only salvation is in that evolution which has led from the primordial cell to Jesus and Plato, and has lifted life from the hunger for protoplasm to the hunger for righteousness. No religion but that of evolution can end anywhere but where it begins, in a chaos of creative purposes thwarted and disrupted, and in an eternal struggle to amend a shattered divine plan"; and "there is one—and that the simplest—explanation of the universe, which, while showing sustained progress in the past, pledges eternal betterment in the future. This is the gospel of hope for all those who choose to go forward with the supreme moral purpose; it is the gospel of degeneration to every one who, declining obedience to the laws of ethical living, contents himself with animal functioning." The charms of the author's poetic mode of thought and warm style are indisputable. The treatise is divided into three parts, the first two of which are introductory to the main argument, which is developed in the third. In the first part are summed up the leading arguments in favor of evolution, as accounting for structural variety, and as able to explain the actual condition of living creatures. These arguments are given in harmony with the expositions of Spencer, Darwin, and Wallace, as the arguments from the Unity of Nature, from Geography, Geology and Anatomy, Development and Reversion, the Power of Mimicry, and Degeneration. In the second part are shown the commonalty of life between all creatures, and how definitely the links in a consecutive development of life have been established, from the jelly-fishes of the primeval seas to man. In the chapter, "Animals on the Road," in this part, numerous incidents are related showing how nearly many animals have approached to human reason, and how closely they have come to sympathy with man and understanding of him. In the third part, evolution is followed after man is reached, to show that there is not only one evolution of all life, including man and animals, interlinked in origin and in their progressive changes, but that human history, its religions, morals, arts, culminating in universal ethical laws, is also a subject of evolution. The chapter, "Co-operation in Evolution," showing how the vegetable and animal world, from the remote past as now, and man co-operate for development, points out, "that from the very outset, evolution has implied something besides a mere brute struggle for existence; that it involved a mutual helpfulness and co-operation for a common good, and that Nature stood pledged in the cell to create a moral intelligence, and in every cataclysm to establish as the ultimate law, 'On earth peace, good-will to men.'" The first men are believed to have appeared while gigantic saurians still prevailed on the earth, and had to contend with them; hence the serpents as powers of evil in the mythologies. The succession in development was kept up with the drift men, cave men, Iberians, Turanians, and Aryans, each race having advantages over the race that preceded it, and marking a step or steps in civilization. Human life, the family, the state, and the Church, underwent a continuous progress under the combined influence of the laws of heredity; of the spontaneity of evolution or the begetting of ideas one from another; of periodicity, or the running of the courses of ideas and lines of thought in given periods; of irritability, of which the stimulus, antagonism, has been the lever of advance; and of slow achievement. The general course of progressive thought began with the knowledge of natural phenomena and attempts to refer them to adequate causes; whence have sprung, in succession, an agglomeration of myth and science, as theology; a code of arbitrary morals, based on existing knowledge and mythology; attacks on established ritualism and belief, ending after bitter strife in a Reformation; and the establishment of the new heresy as orthodoxy, to be in its turn attacked and superseded. Successive steps in the evolution of mankind were marked by the growth of commerce; tribal life; writing; Greek philosophy; philosophy and oratory; Buddha and Confucius; and, finally, Jesus, who from the stand-point of evolution "does not appear as the incarnation of God, but far more than that, as the incarnation of one hundred thousand years of man. Yes, more, as the incarnation of all life, from its dawn on the earth." "No man," the author declares, "can live in the light and the life of the nobler era of brain, of science, of philosophy, of moral truth, and not behold the face of Jesus of Nazareth as the prophet, the foreseer of the later evolution"; and, "it is impossible that those who are not students of evolution, those who suppose men are failures and not a success, and that they were created but a few years ago, should comprehend the character and place of Jesus in history." In the next chapter the workability of the golden rule is inquired into, with the conclusion that it is sure to be approximated, but never absolutely attained; in the next, is considered the future of evolution, which "has to do with a fact larger than man, even with life itself"; in the next, ethics is presented as the aim of evolution. The author next looks for "the self that is higher than ourselves," and finds, not a final cause or God outside of and apart from Nature, but that "the magnificent reign of life and law that is unfolding year by year and age by age is but the pulsating presence of Him who is over all, through all, interpenetrating all." The final chapter relates to "that last enemy, death," and the question of immortality.

Three Good Giants, whose Famous Deeds are recorded in the Ancient Chronicles of François Rabelais. By John Dimitry. Boston: Ticknor & Co. Pp. 246. Price, $1.50.

Unclean as Rabelais is, and wandering seemingly without method around the sphere of thought and coarse wit, the world has agreed that there abound in him gems of thought worth the having—if some one else will dig them out. Mr. Dimitry finds in his great work, too, three admirable characters, whose lives and adventures constitute a wondrous story; and this he has dug out, and presents to young readers free from all that is gross, and untrammeled by philosophical and other disquisitions that do not help it along; or, as he himself expresses it, has placed the famous trio, Grandgousier, Gargantua, and Pantagruel, "high and dry above the scum which had so long clogged their rare good-fellowship, and which had made men of judgment blind to the genuine worth that was in them." He finds a kind of evolutionary development going on in his heroes as the generation proceeds from grandfather to grandson. To these colossal creatures, he says, "fashioned in ridicule of the old fantastico-chivalric deeds of their age, as they come down more and more from the clouds, are more and more given the feelings common to this earth's creatures. All three bear, from their birth, a sturdy human sympathy not natural to their kind, as mediæval superstition classed it. Two of them, in being brought to the level of humanity, join with this a simple Christian manliness and a childlike faith under all emergencies, not set on their own massive strength, but fixed on God. . . . From Grandgousier, the good-hearted guzzler, through Gargantua, through his heady youth and wise old age, to 'the noble Pantagruel,' the gain in purity and Christian manhood is steady." The justification of this conclusion may be sought in the story as the author has picked it out and arranged it. The presentation is most attractive, in bright pages and clear type, with illustrations by Gustave Doré and A. Robida.

The Relative Proportions of the Steam-Engine. By William Dennis Marks, C. E. Third edition, revised and enlarged. Philadelphia: J. B. Lippincott Company. Pp. 295. Price, $3.

In the first edition of this book the author expressed regret at the failure of all writers upon mechanics or the steam-engine to give, in a simple and practical form, rules and formulas for the determination of the relative proportions of the component parts of the engine. In this was the reason for his own effort, the lectures which comprise it having been written with the feeling that a rational and practical method of determination was yet a desideratum in the English literature of the subject. In preparing the lectures, he omitted the consideration of such topics as had already been overwritten, and considered only those which seemed not to have received the attention which their importance demanded. The additions made in the third edition are principally concerning the limitations of the expansion of steam. The importance of taking into account the condensation of steam by the walls of the cylinder is insisted upon. Keeping this point in view, the author has endeavored to formulate the hitherto unknown law of condensation inside of the cylinder. He claims to have shown that the wide differences in experimental results of tests of different types and sizes of engines are not irreconcilable; and it has been sought by quantitative weighing of results to define the limitations of the various expedients which engineers have made in the effort to realize the most from their steam, and to enable others to see where and how they should be used. The whole book is interpaged with blank leaves, on which students can record their notes as they go along.

Johns Hopkins University Studies in Historical and Political Science. Fifth Series. No. VII. The Effect of the War of 1812 upon the Consolidation of the Union. By N. M. Butler. 25 cents. No. VIII. Notes on the Literature of Charities. By H. B. Adams. 25 cents. No. IX. The Predictions of Hamilton and De Tocqueville. By James Bryce. 25 cents. Baltimore: The University. 1887.

These latest issues of this interesting series treat a variety of topics. Professor Butler's work is designed to show how the War of 1812, by uniting the people for the purpose of the common defense, and by stimulating the sentiment of national pride, contributed to produce a more truly national spirit than had prevailed in the country before. He shows how strong the sectional spirit had been before that time, and even during the war itself; and makes it clear that the war was one of the most potent agencies in creating a better public opinion.

The pamphlet by Mr. Bryce is on a more difficult theme, being a review of the opinions expressed by Hamilton and De Tocqueville, respectively, in regard to our national Government and the perils attending its future. The chief dangers, in the view of both writers, were the tendency to sectionalism and disunion, and the apprehended tyranny of the majority. That there was ground for fearing the disruption of the Union, we now know; yet neither the American nor the Frenchman saw that slavery was the prime source of danger. Some of their predictions have proved very far from true; but Mr. Bryce shows that they were much wiser than the opponents of the Constitution in 1788, whose objections have all turned out to be groundless. On the other hand, some of the evils that have actually developed in our politics, and are most observable to-day, such as the abuse of party machinery, the spoils doctrine, and the corrupting influence of wealth, were not foreseen by any one. Mr. Bryce himself carefully abstains from prophesying, believing that predictions in morals and politics are of little value.

The little work by Professor Adams, on the literature relating to charity will doubtless be useful to special students of that subject. It describes the publications of a large number of charitable organizations, together with many works in general literature bearing upon benevolence.

On the Warrior Coal-Field. By Henry McCalley. Montgomery, Ala.: Barrett & Co., State Printers. Pp. 571.

This volume is one of the reports of the Geological Survey of Alabama, which is conducted under the superintendency of Mr. Eugene Allen Smith, State Geologist. It contains descriptions, by counties, of all that has yet been made visible to the surveyor and miner of one of the thickest and fullest coal-fields in the world, the quality of the product of which is, moreover, not excelled by that of any other. The coal lands of Alabama, which belong to the great Appalachian coal-field, comprise, altogether, an area of 8,660 square miles, but are divided up by anticlinal ridges into three parts—the Warrior, the Cahaba, and the Coosa coal-fields. Of these, the Warrier field is very much the largest, for it embraces an area of 7,810 square miles. It is a broad, shallow, tray-shaped depression, sloping toward the southwest, with its southwest end covered by a newer formation, and its southeast side complicated by folds and fractures. It has been conveniently divided into a plateau and basin area, which gradually merge without any distinct line of demarcation. The coal-seams range in thickness from a few inches to about fourteen feet, the thicker seams always containing more or less slate or clay as partings. There appear to be about thirty-five of these seams eighteen inches and more in thickness, of which fifteen are of two feet six inches and over, and six are four feet and over; but they thin out toward the northeast. The quantity of coal is estimated at 113,119,000,000 tons, of which 108,394,000,000 tons would be available coal or contained in the seams of eighteen inches or more in thickness—or about three times as much as the estimated available bituminous and semi-bituminous coals of Pennsylvania. The coals, though all bituminous, are of many kinds and qualities. The amount mined during the past fifteen years had increased in a very rapid ratio from 11,000 tons in 1870 to 2,225,000 tons in 1885; and the amount of coke manufactured from 60,781 tons in 1880 to 304,509 tons in 1885. The Warrior coal-field has besides its coal three or four seams of blackband iron-ore, considerable clay ironstone, great quarries of the best of building and paving stones, and forests of most excellent timber.

A Dictionary of Music and Musicians. Edited by Sir George Grove. London and New York, Part XXII: Macmillan & Co. Pp. 134. Price, $1.

The present part completes the text of this important and comprehensive work, although an appendix and a full index are announced as in preparation. The "Dictionary" as a whole bears ample evidence of the scholarship and careful research of its editor and contributors. It is worthy of a place among the best cyclopædias, while it is also of great account as a literary work and has a very high value as a book of reference. A course of musical instruction might be gathered from the articles in it. It gives accounts of all the different kinds and styles of music; those of the different nations, of different epochs, of the different schools, those which mark the individual traits of composers, those which respond to peculiarities of the people, and those which illustrate or are illustrated by passing events. The several kinds of compositions are described, defined, and distinguished. The various instruments have places among the articles. Biographies are given of all musicians, including composers and performers, who have made their names known, which are full according to the importance of the subject. In short, whatever pertains to the history, character, and accessories of music, is treated, or intended to be treated, in its alphabetical order, in the four volumes. The literary merits of the longer articles make the book desirable from that point of view. The present part contains the articles from "Waltz" to "Zwischenspiel," or the end of the list. The fullest and most interesting among them is Dr. Philipp Spitta's account of Carl Maria von Weber and his works, which occupies more than forty pages, and is bright with the warmth of the writer's appreciation of the brilliant composer and his inspiring music.

Report of Spencer F. Baird, Secretary of the Smithsonian Institution, for the Year 1885-'86. Washington: Government Printing-Office. Pp. 83.

Among the interesting features of this report is the account of the growth of the National Museum, which included, at the time of reporting, 2,420,934 "lots" of specimens. Among the special collections are to be noted that of scientific instruments, to many of which rare historical associations are attached; the baskets, throw-sticks, and sinew-backbones; the aboriginal American pottery; the department of invertebrate fossils, which contains more than 81,000 specimens; and the department of fossil and recent botany, which has been considerably enriched. In field-work, accounts are given of explorations of stone-villages in Arizona and New Mexico—which are decided to be the work of still-existing tribes—and of studies among living Indians.

Twentieth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology. Professor F. W. Putnam, Curator. Cambridge, Mass. Pp. 74.

The museum has now become a department of Harvard University through the recognition of Dr. Putnam, its curator, as Peabody Professor of American Archæology and Ethnology in that institution. The collections have already outgrown the capacity of the new building to fitly accommodate them, and enlargement is called for. The accessions include the Bucklin collection from ancient graves in Peru, a collection of pottery from Piura, Peru; and pottery vessels, whistles and other objects made of pottery, stone implements and carved stones, some circular and others resembling animals, from Chiriqui. The field-work included the watching of operations at the Damariscotta shell-heap, Maine, which is being removed, for human-made objects; Dr. Abbott's explorations in the Trenton gravels; mound and grave explorations in the Little Miami Valley, Ohio, where evidences of the association of cremation and inhumation have been observed; Miss Fletcher's studies of living Indians and their social and religious customs; and Miss Zelia Nuttall's readings of ancient Mexican inscriptions. The present report completes the third volume, including seven years, of the series of reports. The three volumes together furnish a complete history of the institution for twenty years, and represent a great deal of archæological research.

Explorations on the West Coast of Florida and in the Okeechobee Wilderness. By Angelo Heilprin. Published by the Wagner Free Institute of Science of Philadelphia. Pp. 134, with Nineteen Plates.

The Wagner Free Institute of Science, of whose transactions this memoir constitutes the first volume, was founded by the late William Wagner, who, after having accumulated a museum, library, and collections of apparatus, and sustained public scientific lectures for thirty years, bequeathed his property to a Board of Trustees. The Institute was incorporated in 1885, and organized a faculty of four professors, who are to give free lectures, and teach the method of, and make, research. Provision is also contemplated, when resources shall admit of them, in aid of original research, and the publication of its results. The expedition of which the present work records the results was dispatched under its auspices, with the personal co-operation of Mr. Joseph Wilcox, one of its trustees. At the time of Mr. Heilprin's visit, Florida was, in respect to geographical, zoölogical, and geological features, very nearly the least known portion of the national domain. Not even its broader geological aspects had been determined, and nearly every one believed that it was a structure of coral. Observations were conducted on the west coast as far south as the mouth of the Caloosahatchie, and thence eastward into the wilderness of Lake Okeechobee. The zoölogical researches comprised an examination of the littoral oceanic fauna and the fauna of the Okeechobee lake-region, which, in the author's belief, had not hitherto been systematically investigated. Respecting the geological character of Florida, the author concludes that the whole State belongs exclusively to the Tertiary and Post-Tertiary periods, and consequently represents the youngest portion of the United States; that there is not a particle of evidence sustaining the coral theory of the growth of the peninsula, but all the evidence points against it, and indicates that the land has been formed by the usual methods of sedimentation and upheaval; while the coral tract is limited to a border region of the south and southeast. Man's great antiquity on the peninsula is regarded as established beyond a doubt, "and not improbably the fossilized remains found on Sarasota Bay, now wholly converted into limonite, represent the most ancient belongings of man that have ever been discovered."

An Abstract of the Oleomargarine Question. Presented by the Garden City Dairy Company of Chicago. Chicago: Knight & Leonard Company. Pp. 18, legal cap.

The object of this presentation is to point out the existing errors in national legislation on the subject, with the expectation of procuring their correction. The authors admit that legislation to regulate the manufacture of oleomargarine and guard its purity, and taxation commensurate with the taxation of other articles of trade, are proper, but contend that the present acts, being new and on a new subject, need revision; and insist that wrong motives have entered into their construction. There were three motives, they hold, that led to the adoption of the oleomargarine law: to prevent the sale or use of any poisonous or unwholesome article in the guise of butter; to require the new food-product, oleomargarine or butterine (when absolutely wholesome), to be sold honestly under its own proper name, that the consumer might know when he bought oleomargarine that he was not buying butter; and to protect "butter" by taxing oleomargarine and oleomargarine-dealers to such an extent that the business of manufacturing this new food-product might be destroyed. Concerning the first motive, they allege that "the facts show plainly that there was no occasion whatever for the enactment of the law"—there was no impure or unwholesome oleomargarine. As to the second motive, "All thinking and reasoning men admit that the action of the law is a step in the right direction." It is to the advantage of the oleomargarine-man, for his good oleomargarine gets the credit for being what it is; while the buyer of bad butter is informed by the absence of the brand that it is not oleomargarine that he is nauseating himself with. The third motive is altogether bad; and not its least mischievous tendency is to the building up of monopolies. On account of it, the present law should be repealed, to pave the way for a consistent, comprehensive, and wholesome enactment; for its unconditional repeal without any delay "might open the way for a national act concerning the adulteration of food that would commend itself to every citizen, and meet a crying want of the times." Waiting this, the authors propose certain suggestions for the alteration and amendment of the existing legislation.

Revue Internationale, scientifique et populaire, des Falsifications des Denrées Alimentaires. (International Review, Scientific and Popular, of Falsifications of Foods.) Dr. P. F. Van Hamel Roos, Editor. Vol. I, No. 1. September 15, 1887. Amsterdam: Albert de Lange. Bimonthly. Pp. 32. Price, 8 francs a year.

This journal is established in pursuance of a suggestion which was emitted by the editor at the International Pharmaceutical and Chemical Congress of 1885, that a periodical should be published to warn people of all nations against detected adulterations, and to serve as an organ of communication among hygienists and chemists, and promote uniformity of research. The idea was well received, and Dr. Van Hamel Roos, who was at the time conducting a Dutch journal of the same character, has since been preparing to begin the work. He has secured a large list of collaborators and correspondents from most of the important countries of the world, distinguished hygienists, chemists, etc., including Dr. Willis G. Tucker, of Albany, from the United States. The present number is published in French, with a few articles in German or English also; but it is contemplated, if the clientage demands it, ultimately to publish the whole in three languages—French, German, and English. The contents of the number include papers on the measures against adulteration in force in Spain; municipal inspection of provisions at Amsterdam; international measures against adulterations (reports of the Vienna Congress on the subject); analyses of the peptones of commerce; substitutions for spices; adulteration of flour with alum; "Definition of Falsification"; and supplementary articles devoted to hygiene and industry.

Bulletin of the United States Geological Survey, Nos. 30 to 39. Washington: Government Printing Office.

No. 30. Second Contribution to the Studies on the Cambrian Faunas of North America. By Charles D. Walcott. Pp. 369. Price, 25 cents.—This monograph embraces what the author designates as the "Middle Cambrian Fauna," or that which is referable to the Georgia Horizon, but including also formations in the St. Lawrence Valley, Labrador and Newfoundland; Troy, New York; and districts in the Western surveys.

No. 31. Systematic Review of our Present Knowledge of Fossil Insects, including Myriapods and Arachnids. By Samuel H. Scudder. Pp. 128. Price, 15 cents.—This paper is the original form and the authorized English edition of the article which was furnished by Mr. Scudder—who is the most thorough-going of the American students in this branch of paleontology—to Dr. Zittel, for his "Handbuch der Paläontologie," and is furnished, with the concurrence of the author and publisher of that work, for the convenience of English readers.

No. 32. Mineral Springs of the United States. By Albert C. Peale, M. D. Pp. 235. Price, 20 cents.—This book was noticed in the "Monthly" for March, 1887.

No. 33. Notes on the Geology of Northern California. By J. S. Diller. Pp. 23. Price, 5 cents.—This report embraces reconnaissances of the Cascade Range, Mount Shasta, and the Coast and Sierra Nevada Ranges in Northern California and Oregon. The surface features are grouped into two valleys—the Willamette and Sacramento—and three mountain-ranges. The limestone among the metamorphic rocks of the Coast and Sierra Nevada Ranges is referred to the Carboniferous age.

No. 34. On the Relation of the Laramie Molluscan Fauna to that of the Succeeding Fresh-Water Eocene and other Groups. By Charles A. White. Pp. 32, with Plates. Price, 10 cents.—A conception of the importance of the subject of this treatise is given by the conclusion which the author expresses, that there is a complete and unbroken stratigraphical series in the region of his exploration, extending from the Middle Cretaceous to the Upper Eocene, and aggregating nearly or quite two miles in thickness. Yet, while sedimentation was not materially interrupted in a large part of the area, the aqueous life was changed, first from that of a purely marine character to that of alternating brackish and fresh waters, and finally to that of a purely fresh-water character, implying great physical changes without materially interrupting sedimentation. The author also observes that in Western North America the fresh-water deposits rival in extent and thickness the great marine formations. Each of the great lacustrine formations described by him has its own distinguishing fauna, the uniform character of which over great areas is quite remarkable.

No. 35. Physical Properties of the Iron Carburets. By Carl Barus and Vincent Strouhal. Pp. 62. Price, 10 cents. —This paper embodies reports of studies of the internal structure of tempered steel, and of the color-effects produced by slow oxidation of iron carburets.

No. 36. Subsidence of Fine Solid Particles in Liquids. By Carl Barus. Pp. 54. Price, 10 cents.—The author considers the dependence of the rate of descent upon the figure and physical constants of a single particle, or upon the constants of a stated group of particles; tries to find some expression for the dependence of subsidence on the molecular conditions of the liquid; and calls to mind the probability of certain permanent chemical effects of the liquid on the subsiding solid. A second chapter is devoted to the results of experiments upon the dependence of the rate of subsidence on the order of surface, concentration, and turbidity.

No. 37. Types of the Laramie Flora. By Lester F. Ward. Pp. 115, with Fifty-seven Plates. Price, 25 cents.—This is an enlargement of the author's "Synopsis of the Flora of the Laramie Group." The plants described and illustrated in it were collected by himself in the seasons of 1881 and 1883. The principal additions to the original work consist of descriptions of species regarded as new, and critical discussions contributing to the proper understanding of the figures and of the nature of the flora under treatment.

No. 38. Peridotite of Elliott County, Kentucky. By J. S. Diller. Pp. 31. Price, 5 cents.—This memoir concerns dikes of eruptive rock, determined as peridotite, which have been observed in Elliott County, and which the author has studied in co-operation with Professor Crandall, of the Kentucky State Geological Survey. It contains a large proportion of olivine, some of it in well-defined crystals, with proportions of pyrope and ilmenite; is associated with nearly horizontal carboniferous sandstones and shales, from which it differs widely in chemical and mineralogical constitution; and is of special interest, because it affords an instance that is rare of peridotite being found under such circumstances that its eruptive character can be fully established.

No. 39. The Upper Beaches and Deltas of the Glacial Lake Agassiz. By Warren Upham. Pp. 84. Price, 10 cents.— The name of Lake Agassiz is given to the extinct body of water which in Glacial times occupied the basin of the Red River of the North. It is assigned to the closing epoch of the Ice age. The exploration of it was begun by the author in 1879 and continued in 1881 and 1885, first under the State Geological Survey, and in the latter year under the United States Survey. The present report covers what was observed in these explorations, which were limited to the prairie regions in Minnesota and Dakota.

Aperçu de quelques Difficultés à vaincre dans la Construction du Canal de Panama. (A View of Some Difficulties to be Overcome in the Construction of the Panama Canal.) By Dr. Wolfred Nelson, of Montreal. Paris. Pp. 71. Price, 1 franc.

The author resided five years on the Isthmus of Panama, engaged in the practice of medicine, and corresponded with several newspapers, besides contributing memoirs to scientific societies. He once believed in the canal, but the illusion, he says, "has fled, never to return, leaving behind a feeling of 'bitter deception.'" He expresses the firm conviction that the construction of the canal on a level, on M. de Lesseps's line, is a chimerical attempt, if not absolutely impossible. Some of his reasons for believing thus are given in this pamphlet.

Synopsis of the Flora of the Laramie Group. By Lester F. Ward. Washington: Government Printing-Office. Pp. 160, with Thirty-four Plates.

Besides the object suggested in the title of this volume, the author has sought to give a few illustrations of the flora from new material, or from material more ample and abundant than has heretofore existed. The Laramie group, as described by Mr. Ward, is an extensive brackish-water deposit, situated on both sides of the Rocky Mountains, and extending from Mexico far into the British North American territory, having a breadth of hundreds of miles, and representing some four thousand feet in thickness of strata. The immense inland sea of which it is the record, and which occupied the territory now covered by the Rocky Mountains, was partially cut off from the ocean by intervening land-areas, but had one or more outlets through them communicating with the open sea which at that time occupied the territory of the lower Mississippi and lower Rio Grande Valleys. This Laramie sea existed during an immense period of time, and was finally, but very gradually, drained by the elevation of its bed, through the middle of which longitudinally the Rocky Mountains and Black Hills now run. The exact geological age in which it existed is still under discussion.

Journal of the College of Science, Imperial University, Japan. Vol. I, Part III. Published by the University, Tōkyō, Japan. Pp. 124, with Nine Plates.

The publication of such a journal as this, with communications of the character of those which it contains, largely by native Japanese scholars, is a strong testimony to the progress which European studies are making in Japan. The present part of the "Journal" contains papers on the formation of the germinal layers in Chelonia, by Professors Mitsukuri and Ishikarra; "The Caudal and Anal Fins of Goldfishes," by S. Watase; "The Giant Salamander of Japan," by Professor C. Sasaki; "A Pocket Galvanometer" and "The Constants of a Lens," by Professor A. Tanakadate; "Some Occurrences of Piedmontite in Japan," by Professor B. Koto; "The Severe Japan Earthquake of the 15th of January, 1887," by Professor Sekiya; and "Notes on the Electric Properties of Nickel and Platinum," by Professor C. G. Knott.

A Questao dos Vinhos—Os Vinhos Falsificados. (The Question of Wines—Falsified Wines.) By Dr. Campos da Paz. Rio de Janeiro. Pp. 373.

The author was formerly an effective member of the Central Junta of Public Hygiene, and is adjunct to the Chair of Organic and Biological Chemistry in the Faculty of Medicine at Rio Janeiro. In the present volume, he subjects the whole question of the adulteration of wines to a careful examination, with many results of analyses and experiments.

The Microbes of Nitrification. By Manly Miles. Pp. 4.

Accepting the agency of an organized ferment in the nitrification of plant-food, the author, forecasting the future advantages to arise from the methodical study of it, recommends that provisions be made for such study at agricultural colleges, and experiment stations, and suggests outlines of directions and methods for the studies. Further, as the roots, particularly of leguminous plants, appear to exert influence over the microbes, investigation may also be profitably pursued in that direction.

Proceedings of the Seventh Annual Meeting of the Society for the Promotion of Agricultural Science. 1886. William R. Lazenby, Columbus, Ohio, Secretary. Pp. 88.

The meeting was held in Buffalo in August, 1886. The society has so far got along without a constitution, expecting to develop one out of its experiences. In the mean time, so long as it works truly to its name, a constitution will be quite dispensable. Among the papers read at the meeting were two on the subject of dew and its deposition, one on "Parasitic Fungi as Affecting Plant Distribution," one on "The Effects of Lime in the Soil in the Development of Plants," a list of the "Weedy Plants of Ohio," and an account of "A Contagious Disease of the European Cabbage-Worm, and its Economic Application."

THE MERIDIONAL DEFLECTION OF ICE STREAMS. By W. J. McGEE. Pp. 16.

THE moraines of certain Quaternary glaciers in the Sierras of Eastern California, show curvature or deflection in particular directions which appear independent of topographical conditions. The author's study was to find the causes of deflection. He concludes that the relation of the factors is such as to indicate the general law that ice-streams flowing upon plains are deflected toward the sides upon which effective solar accession is least; a law which appears adequate to explain the common curvature of the moraines of the Sierras.

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New York Association for Improving the Condition of the Poor. Forty-fourth Annual Report, 1887. Pp. 46.

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POPULAR MISCELLANY.

The Scientific Department of Brown University.—Brown University holds a respectable rank with the other colleges in this country of the same grade in its scientific department. Several of its officers of instruction who, in previous years, have filled chairs in this department achieved both success and reputation, and their names are well known in the circles of scientific men. It implies no invidious distinction to make special mention of the names of President Alexis Caswell and Professor George Ide Chace, the former well known in the Department of Natural Philosophy and Astronomy, and the latter in that of Chemistry. In the year 1850, under the presidency of Dr. Wayland, the university entered upon the trial of an experiment which was the result of the thoughtful deliberation of the distinguished head of the institution. The sum of one hundred and twenty-five thousand dollars was raised, chiefly among the citizens of Providence, so that the new order of things might start on a good financial basis. The radical changes in the proposed methods in carrying on college education was severely criticised by what may be called the conservative press of the country. On the other hand, the secular press, with great unanimity, hailed the movement as one eminently adapted to meet the demands of the age, that education should be brought nearer to the masses, and be better fitted to prepare men for the practical work of everyday life. From the very outset, the adoption of the new plan was followed by a large increase of zeal and thorough devotion to study in the scientific department of the university, and an impetus was given to this department, which, down to the present hour, has never lost its force. Aiming especially to reach and benefit the working-classes, first of all, by training men who, in due time, would be qualified to give instruction to such as sought it in the common walks of life, the projector of the plan wished to go beyond the narrow limits bounded by college walls, and in some way bring the university in direct contact with the producing portion of the community. Accordingly, it was arranged to give a course of lectures upon "The Principles and Processes employed in Calico Printing." Subsequently, Professor Chace delivered eight lectures upon "The Chemistry of the Precious Metals" to jewelers and other workers in those metals. An audience of between three and four hundred, filling Rhode Island Hall, listened with the greatest delight and profit to these lectures. The sentiments of this large body of respectable mechanics found a response in the remark of one of their number: "I see why it is that I have so often failed. I have been doing or trying to do these things all my life, without knowing *why*." The history of the scientific department of the university for nearly forty years is one of constant progress. The chairs of two professorships, that of Chemistry and that of Physics, have been placed on generous pecuniary foundations, and men of marked ability are filling these chairs. By the will of George F. Wilson the fund of one hundred thousand dollars has been paid into the treasury for the Department of Physics. Sixty or seventy thousand dollars of this bequest is to be appropriated to the erection of a physical laboratory. The income of ten thousand dollars is to be used for maintaining the equipment of the laboratory, and the income from the balance of the bequest goes to pay the salary of an assistant. The Department of Chemistry under the charge of Professor John Howard Appleton is in a healthy condition. The same may be said of the Department of Zoölogy and Geology, under Professor A. S. Packard, and that of Astronomy under Professor Winslow Upton. Excellent work is done in all these departments, and young men who may be attracted to the university with the hope of being well trained in courses of collegiate study which accord with their tastes, and such as will fit them for the sort of professional life to which their inclinations lead them, will be sure not to be disappointed.

English Literary Piracy.—As a sample of high-minded journalism in a country where there is a great deal of righteous indignation over the ways of American publishers, we give below a list of original articles and special translations reprinted from this magazine during the past year, *without any credit whatever*, in a London journal called *Health*, of which Dr. Andrew Wilson, F. R. S. E., is the editor. American periodicals in good standing uniformly give full credit for articles from foreign sources which they republish. *The Popular Science Monthly* has never violated this custom, and desires the same measure of justice from its foreign contemporaries:

"A Bald and Toothless Future," *P. S. M.* Oct., 1886; *Health*, Jan. 28.

"Vinegar and its Mother," *P. S. M.* Jan., 1887; *Health*, May 6, 13, and 20.

"Hats as a Cause of Baldness," *P. S. M.* May, 1887; *Health*, May 20.

"Hygiene as a Basis of Morals," *P. S. M.* May, 1887; *Health*, June 10, 17, 24, and July 1.

"Glasgow's Bandy-Legged Children," *P. S. M.*, July, 1884; *Health*. July 8.

"Brain-forcing in Childhood," *P. S. M.*, April, 1887; *Health*, July 8, 15, 22, and 29.

"Variations in Human Stature." (Translated for the *P. S. M.* from *La Nature*.) *P. S. M.*, July, 1887; *Health*, July 29, and Aug. 12.

"Physiology of Freezing." (Translated for the *P. S. M.* from *Die Gartenlaube*.) *P. S. M.*, Sept., 1887; *Health*, Sept. 16 and 23.

"Human Brain-weights," *P. S. M.*, July, 1887; *Health*, Sept. 30.

"Hats and Baldness," *P. S. M.*, Oct., 1887; *Health*, Nov. 18.

Centralization in School-Life.—James P. Applegate, editor of the New Albany, Indiana, "Ledger," in an address before an Editorial Association, considering the evils of the centralizing tendencies of the times, traced their origin to the public schools, when he said: "Teaching and learning have been reduced to a mathematical system and work with the regularity of machinery. Given so much room, so many pupils, so many hours, so many studies, so many pages of each, so many months in one department, so many in another; one class goes into the hopper at one end and goes out at the other. No matter if one head is larger or smaller than another, the brain brighter or duller, the body stronger or weaker, all is grist that goes to that mill and it is all ground with the same burrs. This system produces a certain order of general average intelligence, higher, perhaps, than existed in the days when boys and girls, not classes, were taught, but where are the individual scholars? Passing through the public schools the student, if further pursuing his studies, goes to college, and there the routine, while of a higher order is the same in principle, all class and grade individuality is lost. Do the graduates of our colleges go out as well educated as their forefathers? The average is higher, no doubt, but are they individually as well equipped for the battles of life?"

The International Competitive Exhibition at Brussels.—A great International Competition of Sciences and Industry is to be held, together with a Universal Exhibition, at Brussels, Belgium, during 1888. All products and documents meeting some want or constituting and illustrating progress, are admissible. Money-prizes, medals, and diplomas will be distributed to the value of 500,000 francs, or about $100,000. A circular in the department of "Operating of Mines" describes the subdivisions or classes in which exhibitors in that branch are invited to compete. The first includes the boring of wells and galleries, particularly in wet and loose grounds, with the best methods and appliances for the same;

the safest explosives, processes for avoiding as far as possible the use of explosives, and supports. The second subdivision includes ventilation and lighting, with precautions against fire-damp explosions and the resultant damage. In the third class are invited treatises and plans with reference to the removal of water, extraction, hauling, and loading of the products, and the transportation of the workmen in the shafts. The fourth class embraces the mechanical preparation of the mineral products, manufacture of coke and agglomerated matter, and processes of treatment for burning turf so as to increase its value. The fifth class relates to plans and maps of the subterranean works, provisions against accidents, measures for the saving, relief, and care of the workmen when they occur, institutions for the benefit of workmen in mines, and statistics. In the sixth class are included processes and working-stock for the operating of quarries; and in the seventh class, comparisons of the stones and marbles of different countries, and exhibits of Belgian stones and marbles adapted to all the different purposes of use. Applications should be filed before January 15, and entries made before April 15, 1888, with Armstrong, Knauer & Co., authorized agents, 822 and 824 Broadway, New York.

What can he do?—The great test in life, says General Thomas J. Morgan, in a paper on "Training as an Element of Education," is rather what a man can do than what he knows. Can he use his eyes? Has he good judgment? Is he a man of common sense? Can he think? Does he reason correctly? Has he power of adaptation? Can he organize? Has he executive force? Is he practical? These are the kind of test-questions that are put to the graduates of our schools. Can the "sweet girl graduate" cook a dinner, sweep a room, or superintend a house? Does she have an intelligent interest in passing events? Has she robust health, good habits, self-reliance, energy, and power of endurance? Can the young man lay aside his diploma and keep his father's accounts, write an article for the newspaper, make a business-trip to Chicago, give an intelligent account of the morning's news? Can he lend a hand at home, and turn to some good account in the daily duties of life some of the accumulated stores of knowledge amassed in years of study? Does his education render him more industrious, more skillful and efficient, more ingenious, more persistent, more practically masterful in whatever he undertakes? If he has been trained to use his senses, to acquaint himself with natural phenomena at first hand; if he has been taught to think, to make careful comparison, noting essential differences and significant similarities, making patient inductions and wise generalizations; if he has been led to form fixed habits of thoughtfulness, self-reliance, moral earnestness, inflexibility of purpose, persistent industry, promptness, punctuality, fidelity, unswerving devotion to duty; if, in short, as a result of his school-life, his training has produced a well-rounded character, he will be able to meet all the reasonable demands that society can make upon one who lacks practical experience in actual business. He will readily acquire skill and efficiency in any calling for which his special talents have fitted him. Training gives potency to all the soul's possibilities.

Counterfeiting Gems.—The closest imitations of diamonds and other precious stones can be made out of a mixture of violin-glass and borax. A London lapidary once testified in court that he made all his imitations out of real stones, by taking pale, cheap stones, splitting them, introducing a deeper tone of color, and joining them again, whereby the salable value of the stones was considerably increased. Diamonds are often split, and each half of the gem is made to do duty on a paste foundation on which it has been carefully mounted. The operator then has two gems, at two prices. One Zocolind was accustomed to procure a very thin flake of an inferior example of the stone he wished to "improve," choosing those which had little color. As a bottom for his "make up" he took a bit of crystal which he had shaped for his purpose; covering this with a transparent glue properly colored, he fixed on the flake, and then concealed the joining so well in the setting that customers could be deceived into believing that they had very fine stones. Varieties of the topaz and other stones are often cut and polished and palmed off as diamonds; but this material is costly. A composition for rubies is made of five hundred parts of strass—a specially manufactured glass—twenty parts of glass of antimony, and a half-part each of purple of Cassius and gold. Meek pearls are sometimes very deceptive in appearance, but they can usually be detected by comparison with the real gem, by their brittleness, or by the clumsy and blunt-edged appearance of the drill-holes, which are usually perfect in the real pearls. The scales of a small fish known as the bleak have been used in the formation of false pearls; but as it requires some eighteen thousand of these fish to provide one-pound weight of the pearl-making material, the manufacture is not likely to become extensive.

Preventable Loss in Agriculture.—In a British Association paper on this subject, Professor W. Freame first described the uncontrollable losses which were chiefly such as were determined by meteorological conditions. These, if they could not be anticipated, might to some extent be mitigated by acting upon the recorded practice which had been found most beneficial in similar cases in previous years. Hence the value of such records. Controllable losses were such as might reasonably be anticipated, and therefore provided against, and should be in a very high degree, although not absolutely, preventable. The toleration of such preventable losses might be attributed partly to ignorance, partly to indifference, and partly to empiricism. First among the sources of preventable loss was the imperfect working of the soil, which was a common cause of poor crops in the immediate future and of worse trouble farther on. Another source was the use of bad seed. No greater folly could be conceived than that of introducing upon the land by means of purchased seeds the seeds of weeds and parasites. The most objectionable rubbish was sometimes sown, and heavy expenses were in consequence subsequently incurred. A third source was the encouragement of weeds, of which the most common species were grown at immense cost to the farmer. They robbed him just as much as a pickpocket did who stole his purse. His object was, or should be, to concentrate all the capacities of the soil upon the production of useful crops; every weed that was grown detracted from this purpose. Ignorance of the properties and affinities of weeds was just as deplorable. Some—the cruciferous weeds, for example—harbored and encouraged insect pests till the cruciferous crop they were waiting for was ready to be devoured and destroyed by them. Another source of loss was the deterioration of grass-lands. There were in the British Islands nearly thirty-three million acres of permanent or temporary grass land, which was equivalent to three sevenths of the entire area. Yet, as to the nature of the herbage growing upon this enormous area, ninety-nine farmers out of one hundred were in entire ignorance. A fifth source was from pests. The maintenance of insect-thieves sometimes constituted a severe drain upon farming capital. Yet in no part of his education was the farmer called upon to familiarize himself with the habits of these creatures. Of fungi pests, his knowledge was, if it were possible, even less. Other sources were diseases of live-stock, some of which were preventable and some greatly reduced, while others stood in need of further investigation; and injudicious expenditure. Among the most practicable remedies for these preventable losses, and a means, therefore, for making agriculture a more profitable occupation, was the extension of sound technical instruction in agriculture.

Photography as an Aid to Astronomy.—Mr. A. A. Common believes that some astronomical objects can be studied to better advantage in photographs than in themselves. The brain can not always take in the perceptions of the eye fast enough, and the eye is not sensitive to images whose brightness falls below a certain limit. In photography, a prolonged exposure may be made to compensate for deficiency in luminous power; and the sensitive plate being competent to respond to quicker vibrations than the eye, it is possible to obtain photographs of celestial objects radiating light which the eye is not adapted to receive. While the moon has received much attention, the photographs of it taken by Rutherford, twenty years ago, have not been superseded. The power of photography to portray the nebulæ has been thoroughly demonstrated. The art has been applied to the observation of comets, and may yet be brought into play for the paths of meteors, the discovery of new planets, and other purposes now hardly thought of. After remaining nearly stationary for years, "at a bound it has gone far beyond anything that was expected of it, and bids fair to overturn a good deal of the practice that has hitherto existed among astronomers."

Indian Villages in New York.—In his American Association paper on "Aboriginal Villages in New York State," Dr. W. M. Beauchamp traversed the famous theories of Mr. Lewis H. Morgan of the "long houses" of the Iroquois. In the highlands, he said, forts were commonly long and narrow, often two or three times as long as wide, and usually with the houses in the narrow part, leaving the wider portion for public uses and games. The long house was not peculiar to the Iroquois, nor prominent among them, and facts in this matter have yielded to theories. Greenhalgh noticed these large lodges in only one town, and Morgan's estimate would give that town five times the whole Seneca population. The traveler's account gave but an average of two or three warriors to a lodge throughout the five nations. The form of the forts often afforded but little room for long houses, especially in those examined by the author. Among the Iroquois they do not prove communal life. Early writers often refer to ownership of fields, and Sir William Johnson said that every nation and tribe had its own district and well-known portion of land.

Trees for Plantation around Houses.—Dr. Charles Roberts, considering the subject from the sanitary point of view, advises that while belts of trees may be planted on the northern and eastern aspects of houses, on the east side the trees should not be so near nor so high as to keep the morning sun from the bedroom windows in the shorter days. On the southern and western aspects of the house isolated trees only should be permitted, so that there may be free access of the sunshine and the west winds to the house and grounds. Pine trees are the best of all trees to plant near the house, as they collect the greatest amount of rainfall, and permit the freest evaporation from the ground. Acacias, oaks, and birches are late to burst into leaf, and therefore allow the ground to be warmed by the sun's rays in early spring. The elm, lime, and chestnut are the least desirable trees to plant near houses, although they are the most common. They both come into leaf and cast their leaves early, so that they exclude the spring sun and do not afford much shade in the hot autumn months, when it is most required. Trees are often useful guides to the selection of residences. Numerous trees with rich foliage and a rank growth of ferns or moss indicate a damp, stagnant atmosphere; while abundance of flowers and fruit imply a dry, sunny climate. Pines and birches indicate a dry, rocky, sandy, or gravelly soil; beeches, a dryish, chalky, or gravelly soil; elms and limes, a rich and somewhat damp soil; oaks and ashes, a heavy clay soil; and poplars and willows, a low, damp, or marshy soil. Many of these trees are found growing together, and it is only when one species predominates in number and vigor that it is truly characteristic of the soil and that part of the atmosphere in connection with it.

The Cross Timbers of Texas. — The "Cross Timbers" of Texas are two long and narrow strips of forest region between the ninety-sixth and ninety-ninth meridians, extending parallel to each other from the Indian Territory southward to the central portion of the State, and forming a marked exception to the usual prairie features of the country. They are about fifteen miles wide, and fifty miles apart, and are separated by a timberless prairie region. Both are lower in level than the country through which they extend. The western strip, because it is higher in position, though geologically lower, is called the upper, and the eastern strip the lower cross timber. The soil in both is sandy, but that of the eastern strip is less siliceous, with some iron, is considerably more fertile than that of the western, and shows corresponding differences in its vegetation. Various theories have been proposed to account for the existence of these woodlands—among them, that they represent rivers or inlets of the Tertiary sea; that they are the beds of extinct lakes; and that they represent the beds of Quaternary rivers. Mr. R. T. Hill, who has made a geological examination of the region, finds all these theories wrong. He sees in the ground on which the timbers grow, the detritus of arenaceous strata which occupy well-defined horizons in the geologic series, and which have been exposed by the denudation of the overlying strata. The timber confines itself to these arenaceous belts because they afford a suitable matrix for the penetration of the roots of trees and a constant reservoir for moisture; while "the barrenness of the prairies, so far as forest growth is concerned, is owing to the absence of the requisite structural conditions for preservation of moisture as well as to the excess of carbonate of lime in their soils."

Injuries caused by Parasitic Fungi.—The injuries which parasitic fungi produce upon their host plants, were described in the American Association by A. B. Seymour. Parasites take away the nutriment of the plants, killing or continually absorbing the food-supply of individual cells, and injuring cell-walls. They impair the power of assimilation, weaken the physiological power, causing the formation of spots and of black molds to obstruct the passage of light. Some fungi cause a change of position in their host, and less favorable exposure. They provoke abnormal acceleration or retardation of growth, with resultant distortion and impaired vitality. Any part of the plant may be affected. In many grasses the entire inflorescence is destroyed. Decay is produced in ripe fruits, and valuable plants become infected with disease from less valuable ones. The extent of the injury attributable to any one cause is hard to determine, because several causes act together.

Deceptive Sensations.—The evidence of our senses is correct in nearly all cases in which two of them are called into play, so that the testimony of one is checked by that of the other. But when we have to rely upon one sense alone, we are sometimes liable to curious deceptions. This is the case with some of the feelings of touch. In hip-joint disease the pain is often referred to the knee, while it is really in the hip. This is because the nerve which conveys sensation from the knee, also sends a branch to the hip-joint. The experiences of those who have lost a limb are familiar. For some time afterward they feel sensations and pains of all sorts in the member that is gone, so that they can hardly convince themselves that it is not still there, itching or aching or smarting. This is because the nerve which used to convey feeling to the lost extremity is affected by some temporary accident. The feeling, which may be real, as to the trunk that remains, is still, by force of habit, referred to the extremity whence it used to come. Another experiment in deceptive sensations may be made by crossing the second finger over the first, and then placing a marble between the tips of the fingers, when it will be almost impossible to convince one's self that there are not two marbles. This is because two points in the fingers are touched simultaneously, which in the ordinary position could only be touched at the same time by two marbles. Acting upon its previous knowledge, the brain says that there are two.

Relative Mortality of Social Classes.—Mr. Noel A. Humphreys, in a paper on the relative mortality among the different classes in society, after citing the general evidence of the British life-tables that the mean duration of life has perceptibly and steadily increased in recent years, shows that this factor is mainly controlled by the rate of mortality in childhood; and the expectation of life is regarded in the life-tables as greater at ten years of age than it is at birth. Subsequently to childhood, the greater vitality of the upper and middle classes, compared with that of the general population, is only somewhat less marked than it is at under five years of age. The statistics of mortality, according to occupation, show a great difference in favor of quiet pursuits, and, among workingmen, of those engaged in the country as against those occupied in cities. Many of these differences are doubtless due more to the influences and risks of occupation than to the mere influence of class; and the differences between rural and urban laborers to differences of housing and sanitary surroundings; for both classes probably suffer about equally from poverty, hard work, and hard living. The great reduction in the rate of mortality among the inhabitants of the Peabody buildings, as compared with other tenement-house dwellers, points to one method of bringing the mortality of the working-classes within sanitary control. These and other similar facts indicate further reductions in the now rapidly declining English death-rate, the possible extent of which it is not easy to estimate.

Glaciation on the Pacific Coast.—Mr. G. Frederick Wright has, in the "American Naturalist," some notes on the "Glaciation of the Pacific Coast in Oregon and Washington Territory." At Sims's Station, Dakota, forty miles west of Bismarck, the passage from the glaciated to the unglaciated region is quite marked, and can easily be detected from the train. The next signs of glaciation are near Lake Pend Oreille, in Idaho, water-worn pebbles from whence are observed in old water-courses far down in Eastern Washington Territory. West of the Cascade Mountains, all the streams coming down from Mount Rainier and its companions are heavily charged with glacial mud, and can be traced to extensive glaciers in the mountains. The largest of them, White River glacier, on the north side, is from one to one and a half mile wide at its termination at about five thousand feet above tide, is about ten miles long, and in its higher level merges in the general ice-cap which envelops the upper five thousand feet of the mountain. The shores and islands of Puget Sound have every appearance of being a true glacial accumulation, while the north shore of the Strait of Juan de Fuca, near Victoria on Vancouver's Island, is remarkably clear of glacial *débris*; the rocks near Victoria exhibit some of the most remarkable effects of glacial scoring and striation anywhere to be found. About thirty-five miles up the Stikine River, two glaciers of immense size are encountered coming down, one from the north and one from the south, to the vicinity of the vast cañon through which the river runs. It is clear from observation of the situation that a comparatively slight extension of these two glaciers would make them unite and close up the mouth of the river; and the Indians have a tradition that within historic times these glaciers met and the Stikine River made its way under them through an immense tunnel. From the mouth of the Stikine River northward, glaciers in great numbers and of great size are seen coming down from the mountains toward the sea-level, while all the mountains upon the islands are snow-clad through the whole summer, and some of them contain glaciers of small size. At the head of Glacier Bay no less than four glaciers of great size come down to tide-level, sending off immense numbers of small fragments and bergs. The evidence here of the vast extension of these glaciers down the bay, and of the facility of glacier-ice in adjusting itself to the local topography, is of the most explicit and interesting character. The present formation of glaciers on the coast of Southwestern Alaska is favored not so much by the coolness of the climate as by the elevation of the mountains, and the excessive amount of precipitation. There is no evidence that the elevation of the coast has materially changed in recent times. Nor is there evidence of any changes in the amount of precipitation. It would only be necessary to suppose a slight diminution of temperature to secure all the additional force required to extend the present glaciers of Southeastern Alaska, British Columbia, and of the Cascade Range in Washington Territory and Oregon, far down into the South, where the marks of former glacial action are now seen.

The Use of a Snake's Rattle.—The purpose of the rattlesnake's rattle has been the subject of much speculation. Mr. O. P. Hay, in the "American Naturalist," thinks that it is a warning to approaching enemies to keep them away. The warning must have been very efficient with most animals. The snakes are, of course, in great danger of being trodden upon by animals which do not intend directly to attack them—buffaloes, for instance—and to attempt war on a herd of large animals would be useless. But through the simple device of sounding the rattle, each animal as it approached would be warned of the presence of the snake, and would probably be induced to give it abundant space. Doubtless, by this means, the snakes have been saved from many a rude tread by bear or wolf or panther that would have been unpleasant to them, and might have involved them in a fight in which they had everything to lose and nothing to gain.

Mineral Fibers.—Mr. C. V. Boys, describing in the Physical Society in London "The Production, Preparation, and Properties of the Finest Fibers," said that in producing very fine glass-fibers, he found it best to use very small quantities at high temperatures, with a velocity of separation as great as possible. In the last point, the best results are given by a cross-bow and straw arrow, to the tail of which a thin rod of the substance to be drawn is cemented. By this means, fibers of glass less than $\frac{1}{10000}$ of an inch in diameter can be made. The author had also experimented on many minerals, with more or less success. Ruby, sapphire, and fluor-spar could not well be drawn into fibers, but quartz, augite, and feldspar gave very satisfactory results. Garnet, when treated at low temperatures, yielded fibers exhibiting the most beautiful colors. From quartz, fibers less than $\frac{1}{100000}$ of an inch in diameter had been obtained. The thread can not be drawn directly from the crystal, but the latter has to be slowly heated, fused, and cast in a thin rod. Quartz-fiber seems to be free from the torsional fatigue so evident in glass and metallic fibers, and is therefore valuable for instruments requiring torsional control. The tenacity of such fibers is about fifty tons on the square inch.

Photographing Birds.—Dr. R. W. Shufeldt suggests, in "The Auk," to ornithologists that they may find a portable photographic outfit of advantage in their studies. He finds that by the use of the instantaneous shutter, birds may be photographed in nearly all of their positions. "Out here on the prairies we will often find an old stump or stalk upon which a dozen or fifteen species of birds will alight during seven or eight hours, on almost any day suitable to use the camera upon them. Now, all we have to do is properly to set up our instrument near this point, conceal it in such a way as not to alarm the birds, focus it sharply upon the perch where they alight, place on your 'snap-shutter,' and fix it with a string, and then remove yourself far enough away to pull it when you have a subject sitting to your liking. Birds that you have wounded but slightly may be photographed under the most favorable circumstances; they may also be taken sitting on their nests; in actual flight, however swift; in pursuit of their food; in leading about their young; indeed, the list is almost an endless one. Rookeries also offer admirable subjects, and a splendid field is open at those wonderful resorts of water-birds in such places as the Bahamas or the Alaskan coasts."

NOTES.

The Leander McCormick Observatory of the University of Virginia, Professor Ormond Stone, director, devoted much attention last year to the nebula of Orion, in which the director believes that the principal changes going on are of brightness. Besides these, three hundred and fifty-one observations of miscellaneous nebulæ have been made, resulting in a large number of sketches, and in the discovery of two hundred and seventy nebulæ which are supposed not to have been hitherto detected. A working-list of all known nebulæ north of thirty degrees south declination, which are as bright as the fourteenth magnitude, has been made to aid in the determination of nebular motions. Three independent publications have been issued, and six articles published in astronomical periodicals.

The recent Manchester meeting of the British Association appears to have been one of the most successful that was ever held. It was said, at the close of the proceedings, that Manchester had surpassed all other places visited by the Association, alike in the numbers attending, the amount received in subscriptions, and the amount which the Association in its turn was enabled to vote for scientific research.

A committee was appointed by the Chemical Section of the British Association, at the Manchester meeting, 1887, to inquire into and report upon the methods adopted for teaching chemistry in the various schools. It consists of the representatives of the universities and colleges, schools and technical institutions in which chemistry is taught. This action was taken after expressions of dissatisfaction in a discussion on the subject, with the present methods of teaching the science, and of the desire for important changes.

Mr. T. Mellard Reade has projected a new theory of the origin of mountains, which contradicts all the other theories. Having shown that periods of great sedimentary deposit precede the birth of every large mountain-chain, he supposes, as Babbage has proved, that a great elevation of temperature ensues, producing expansions of the strata. These being prevented from spreading horizontally by the rigid mass of the earth's crust that bounds the local area, can only swell upward and cause those ridges which we know as mountains. The author has tried experiments in the mechanical effects of expansion by heat on various rocks, and has found a similar result in miniature produced upon them.

Barrels are made in Jersey for the use of the Channel Islands farmers which will fold up when empty, and thus, having been sent to market, can be packed into a small space on the return. The staves are fixed upon the hoops so that, the heads being removed, they may be rolled up. They are made perfect cylinders, and therefore occupy less space for the same capacity than ordinary barrels.

Sir James Paget spoke at a school festival, some time ago, of the importance of "learning how to learn," and showed that knowledge not immediately useful in itself may be the means of developing the power of learning in the mind acquiring it. The cultivation of the faculty of knowing is of incomparably greater importance than the mere acquisition of knowledge; and to the student this faculty, so developed that when need arises, knowledge may be quickly obtained, is a better provision for the business of life than is afforded by the largest and richest stores of information packed away in the memory; thus the brain-property most worth carrying about is the power of finding at pleasure and learning at will precisely what is wanted.

Oyster-culture has had a great development in France. Thus, while in 1857 there were in the Bay of Arcachon twenty parks, or district oyster-beds, in 1865 there were 297 beds, producing 10,000,000 oysters annually; and there are now 15,000 acres of beds, yielding an annual supply of 300,000,000 oysters. From Auray, on the coast of Brittany, 7,000,000 oysters were sent to market in 1876-'77; in 1885, the numbers exceeded 70,000,000. On the other hand, the British oyster-industry has declined; and the coast which furnished ancient Rome with oysters, and within a generation exported then to Paris, now ranks low in the list of oyster-nurseries.

The recent International Hygienic Congress at Vienna was attended by twenty-two hundred and fifty members. M. Brouardel spoke upon typhoid fever, which he said was a far more dangerous disease to man than cholera. Concerning its origin—whether from the decomposition of organic matter or from specific virus—there was still an open question. Herr Pettenkofer, in a lecture on hygienic instruction in universities and technical schools, dwelt on the necessity of spreading hygienic principles among all classes of society. He referred to the statistics of mortality of London as showing how hygienic piety there had been rewarded.

The climate of the Sandwich Islands is peculiarly adapted to the cultivation of rice of a superior quality and in great quantity, its evenness of temperature permitting the raising of two crops a year without any particular strain upon the soil. The crops are raised in fields called patches, most of which were formerly used by the natives for raising *taro*, and which are often not more than an acre in extent. The fields are situated in the lowlands, where abundant irrigation can be obtained, and sometimes on slight elevations where artesian wells can be successfully established, and are the highest-priced lands in the kingdom. The cultivation is almost entirely in the hands of the Chinese.

Mr. Mayall, a London photographer claims to have perfected a system of photography in colors. He takes a negative on a specially sensitized plate; from this a positive is produced on a chemically treated basis by the aid of a solar camera and a spectroscopic arrangement. The image is produced in colors on the basis without the aid of hand-work or brush. The colors are said to be all hydrocarbons, specially prepared and capable of subdivision to the 180-millionth of an inch. When the colored picture is produced by chemical action, the image exists between two films not more than the hundredth part of an inch in thickness. These photographs are said to be permanent and not affected by climate.

M. Wiecyk has observed that the workmen in the petroleum-mines of the Carpathians, having to breathe an air contaminated with various hydrocarbons, carbonic acid and oxide, and sulphureted hydrogen, are not rarely subject to asphyxia. They are also exposed to tingling in the ears, dazzling, beating of the arteries of the head, syncopes, and hallucinations of usually an agreeable character. The respiration of petroleum-vapors induces at first feelings of lightness in the breast and greater freedom in breathing, but in the end palpitations and general weakness. The rareness of consumption and infectious and epidemic diseases among the workmen is remarked upon.

M. Olszewski has, by the aid of excessively low temperatures, liquefied the more permanent gases at pressures averaging only 740 millimetres, and has also determined the boiling-points, melting-points, and densities at atmospheric pressure. The boiling-points have thus been determined: Of methane, —164° centigrade; oxygen, —181·4°; —nitrogen, —194·4°; carbon monoxide, —190°; and nitric oxide, —153·6°. The melting-point of carbon monoxide was also determined to be —207°, and that of nitrogen —214°. M. Olszewski's nearest approach to absolute zero was —225° C., or —373° Fahr., for solid nitrogen. The density of methane at 736 mm. and —164° C., was found to be 0·415; that of oxygen at 743 mm., and —181·4° was 1·124; and that of nitrogen at 741 mm. and —194·4° was 0·885.

Professor Schnetzler has described a curious moss which grows at the depth of two hundred feet in the sub-lacustrine moraine of Yvoire. It contains grains of chlorophyl perfectly formed.

OBITUARY NOTES.

Count August von Marschall, Director of the Archives of the Geologische Reichanstalt of Vienna, died recently near that city, at the age of eighty-two years. He was the author of several scientific works.

Oscar Harger, Assistant Professor of Paleontology in Yale College, died in New Haven, November 6. He was born in 1843, was graduated from Yale in 1878, and, having devoted himself to the study of Natural History, became a co-worker with Professor Marsh. He was on the staff of the dredging expedition of the coast-survey steamer Bach to St. George's Banks in 1871, and accompanied Professor Marsh on his geological expeditions in 1871 and 1873. Among his contributions to scientific literature were the catalogue of isopods in Verril and Smith's "Invertebrata of Southern New England," and "A Report on the Marine Isopoda of New England and Adjacent Waters."

M. H. Bayard, who recently died in Paris at the age of eighty-one years, discovered a photographic process, in 1839, almost simultaneously with Daguerre and Talbot. He delayed to perfect and publish his discovery and thereby lost the priority which it is asserted he might easily have claimed.

The death is reported of Dr. E. Luther, Professor of Astronomy and Director of the Observatory at Königsberg, Germany, in the eighty-first year of his age.

Dr. Robert Caspary, Professor of Botany in the University of Königsberg, died recently from the effects of a fall downstairs. He was born in 1818, and, while not a prolific writer, was well known to botanists as a critical authority on Nymphæaceæ.

The Rev. William S. Symonds, F.G.S., rector of Pendock, who died September 15, was an earnest student of British geology, and contributed papers to the scientific periodicals on the rocks and fossils of the west of England. He paid, however, more attention to physical geology than to paleontology; and was greatly interested in the phenomena of the glacial drifts, and in questions relating to the antiquity of prehistoric man. He was the author of "Records of the Rocks," "Old Stones," and "Old Bones," of more than forty papers in scientific journals, and of the romances "Malvern Chase" and "Hornby Castle."

Joseph Maxendell, a British meteorologist and astronomer of eminent local reputation, died in Southport, October 7, in the seventy-second year of his age. He is declared by Balfour Stewart to have been the pioneer in the suggestion of the eleven-year sun-spot theory of meteorological cycles, and to have been the first to propose the use of storm-signals as they are now adopted by all maritime nations. He was a member of many learned societies at home and abroad.

Robert Hunt, F. R. S., keeper of the British Mining Records, died October 17, in the eighty-first year of his age. He had been writing on scientific subjects for nearly fifty years. While a medical student, he became acquainted with pharmaceutical chemistry. During a walking tour, he collected the materials for a book on west of England folk-lore. He studied and wrote upon photography, crystallization, the chemical action of light (in relation to which he introduced the term actinism), the influence of colored media on plant-germination and growth, and other kindred subjects. He was the originator of the publication of statistical returns of the mineral produce of the United Kingdom; and in 1866 was one of the commissioners to inquire into the stock of unworked coal in the mines. He published, in 1884, a comprehensive book on British mining. He was author of works on the "Poetry of Science," "Panthea, or the Spirit of Nature," and "Handbooks" of the great Exhibitions of 1851 and 1852; and he edited, after Dr. Ure's death, the successive editions of that author's "Dictionary of Arts."

Mr. Thomas Bolton, of the Microscopists' and Naturalists' Studio, Birmingham, England, died November 7th. His services as a naturalist and microscopist were recognized several months ago by the award of a civil-service medal, in connection with which a memorial, signed by many eminent men of science, was presented, setting forth his claims and discoveries.

SIR JOSEPH WHITWORTH.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

By ANDREW DICKSON WHITE,
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IV.—GEOLOGY.

AMONG the philosophers of Greece and Rome we find, even at an early period, germs of geological truth, and—what is of vast importance—an atmosphere in which such germs could grow. These germs were transmitted to Roman thought; an atmosphere of tolerance continued; there was nothing which forbade unfettered reasoning either upon the earth's strata or upon the remains of former life found in them, and under the empire a period of fruitful observation seemed sure to begin.

But, as Christianity took control of the world, there came a great change. The earliest attitude of the Church toward geology and its kindred sciences was indifferent, and even contemptuous. According to the prevailing belief, the earth was a "fallen world," and was soon to be destroyed. Why, then, should it be studied? Why, indeed, give a thought to it? The scorn which Lactantius had cast upon the study of astronomy was extended largely to other sciences. St. Jerome summed up the general feeling of the Church in his time by asserting that the broken and twisted crust of the ruined earth exhibits the wrath of God against human sin. St. Augustine showed this feeling at various times in a very marked degree.*

But the germs of scientific knowledge and thought developed in

* For a compact and admirable statement as to the dawn of geological conceptions in Greece and Rome, see Mr. Lester Ward's masterly essay on paleobotany in the "Fifth Annual Report of the United States Geological Survey," for 1883-'84. For the reference to St. Jerome, see Shields's "Final Philosophy," p. 119; also Lyell's "Introduction to Geology," vol. i, chapter ii. As to the reasons why Greek philosophers did comparatively so little for geology, see D'Archiac, "Géologie," p. 18.

the ancient world could be entirely smothered neither by eloquence nor logic, and St. Augustine himself began an effort to evolve from these germs a growth in science which should be "sacred" and "safe." With this intent he prepared his great commentary on the work of creation, as given in Genesis, beside touching upon the subject in other writings. Once engaged in this work, he gave himself to it more earnestly than any other of the earlier fathers ever did; but his vast powers of research and thought were not directed to actual observation or reasoning upon observation; the key-note of his whole method is seen in his famous phrase, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind." * All his thought was given to studying the letter of the sacred text, and to the application of it by methods purely theological.

Among the many questions he then raised and discussed may be mentioned such as these: "What caused the creation of the stars on the fourth day?" "Were beasts of prey and venomous animals created before or after the fall of Adam? If before, how can their creation be reconciled with God's goodness; if afterward, how can their creation be reconciled to the letter of God's word?" "Why were only beasts and birds brought before Adam to be named, and not fishes and marine animals?" "Why did the Creator not say, 'Be fruitful and multiply,' to plants as well as to animals?" †

As to the creation of animals, Augustine curiously anticipates the Darwinian theory in his statement that birds take their origin in water. As to land animals, he holds that insects were not created "actually" during the six days, but only "potentially and virtually" so, since they sprang afterward from carrion.

Such was the contribution of the greatest of the Latin Fathers to the scientific knowledge of the world, after a most thorough study of the biblical text, and a most profound application of theological reasoning. The results of this contribution were most important. In this, as in so many other fields, Augustine gave direction to the main current of thought in Western Europe, Catholic and Protestant, for nearly thirteen centuries.

In the ages that succeeded, the vast majority of prominent scholars followed him implicitly. Even so strong a man as Pope Gregory the Great yielded to his influence, and such leaders of thought as St. Isidore, in the seventh century, and the venerable Bede, in the eighth, planting themselves upon Augustine's premises, only ventured timidly to extend their conclusions upon lines he had laid down.

In his great work on "Etymologies," Isidore took up Augustine's attempt to bring the creation of insects into satisfactory relations with the book of Genesis, and, adopting the theory of the ancient philoso-

* For citations and authorities on this point, see my chapter on "Meteorology."

† See Augustine, "De Genesi," ii, 13, iii, 13, 15, *et seq.*, ix, 12, *et seq.*

phers, declared that bees are generated out of decomposed veal, beetles out of horse-flesh, grasshoppers out of mules, and scorpions out of crabs. Under the influence of the biblical account of Nebuchadnezzar, which appears to have taken strong hold upon mediæval thought in science, he declared that human beings had been changed into animals, especially into swine, wolves, and owls. As to fossil remains, he, like Tertullian, thought that they resulted from the Flood of Noah.*

In the following century Bede developed the same orthodox traditions in science; but he held with St. Jerome that the reason why God did not pronounce the work of the second day good is to be found in the fact that there is something essentially evil in the number two. As to the Deluge, he discussed the question as to the amount of food taken into the ark, and declared that there was no need of a supply for more than one day, since God could throw the animals into a deep sleep, or otherwise miraculously make one day's supply sufficient.†

The difficulty in making Noah's ark large enough to contain all the animals had begun to be seriously felt even at that period. Origen had dealt with it by supposing that the "cubit" in Noah's time was six times greater. Bede explained Noah's ability to complete such a Herculean task by supposing that he gave to it a hundred years; and he leaned toward diminishing the number of animals taken into the ark, supporting himself upon Augustine's theory of the after development of insects out of carrion. In this way the strain upon faith required in believing that all the animals were literally brought into the ark was somewhat lessened.

The best guess in a geological sense among the mediæval followers of St. Augustine was made by an Irish monkish scholar,‡ who, in order to diminish the difficulty arising from the distribution of animals after the flood, especially in view of the fact that the same animals are found in Ireland as in England, held that various lands now separated were once connected. Fortunately for this theologian, the fact that the kangaroo is only found on a continent in the South Pacific, and so, in accordance with the theory, must either by a single leap have jumped from Mount Ararat to Australia, or have found his way across a causeway temporarily erected between Armenia and the South Pacific continent, had not been discovered.

These general lines of thought upon geology and its kindred science of zoölogy were followed by St. Thomas Aquinas and by the whole body of mediæval theologians, so far as they gave any attention to such subjects.

But there was one influence coming from the Hebrew Scriptures which wrought to mitigate ideas regarding the worthlessness of any study of Nature; this came from the grand utterances in the Psalms

* See Isidore, "Etymologiæ," xi, 4, xiii, 22. † See Bede, "Hexæmeron," i, ii.

‡ The so-called Pseudo-Augustine. His treatise, "De mirabilibus mundi," is usually appended to the works of Augustine.

regarding the beauty and wonders of creation, and we see the glow of this noble poetry radiated upon those whom logic drew away from studies in natural science. Some of the results produced were indeed curious. Thus, in the science of zoölogy, so essentially connected with geology, Vincent de Beauvais and his compeers, while showing a great desire to display to their readers the glories and wonders of Nature, rely in their attempts to do so, not upon observation but upon authority. Neglecting the wonders which the dissection of any animal would have afforded them, they amplified statements found in various mediæval legends, and especially in the lives of the saints. Hence such additions to learning as careful descriptions of the unicorn and dragon mentioned in Scripture, and such statements as that the lion when pursued by hunters effaces his tracks with the end of his tail; that the hyena can talk with shepherds, and changes its sex every year; that a certain bird is born of the fruit of a certain tree when that fruit happens to fall into the water; and innumerable other statements equally valuable.*

Very pious uses were made of this science, especially by monkish writers. The phœnix rising from his ashes proved the doctrine of the Resurrection; the structure and mischief of monkeys proved the existence of demons; the fact that certain monkeys have no tails served to prove that Satan was shorn of his glory; the weasel, which constantly changes its place, was exhibited as a type of man estranged from the word of God, and finding no rest.†

The next great development, mainly under Church guidance, was by means of the scholastic theology. Phrase-making was substituted for investigation. Without the Church and within it wonderful contributions were thus made. In the eleventh century Avicenna accounted for the fossils by suggesting a "stone-making force"; ‡ in the thirteenth, Albert the Great attributed them to a "formative quality." # In the following centuries some philosophers ventured the idea that they grew from seed, and the Aristotelian doctrine of spontaneous generation was constantly used to prove that these stony fossils possessed powers of reproduction like plants and animals.‖

Still, at various times and places, germs implanted by Greek and Roman thought were warmed into life. The Arabian schools seem to have been less fettered by the letter of the Koran than the contemporary Christian scholars by the letter of the Bible; and to Avicenna belongs the credit of first announcing substantially the modern geological theory of changes in the earth's surface. ^

* See Berger de Xivrey, "Traditions tératologiques," and such mediæval books of *exempla* as the "Lumen animæ."

† See Rambaud, "Histoire de la Civilisation française," Paris, 1885, vol. i, pp. 368, 369.

‡ "Vis lapidifica." # "Virtus formativa."

‖ See authorities given in Mr. Ward's essay, as above.

^ For Avicenna, see Lyell and D'Archiac, and from these it appears that at least one

The direct influence of the Reformation was at first unfavorable to scientific progress. Nothing could be more at variance with any scientific theory of the development of the universe than the ideas of the Protestant leaders. The strict adherence to the text of Scripture which made Luther and Melanchthon denounce the idea that the planets revolve about the sun, would naturally be extended to every other scientific statement apparently at variance with the sacred text. There is much reason to believe that the fetters upon scientific thought were closer under the strict interpretation of Scripture made by the early Protestants than they had been under the older Church. The dominant spirit among the reformers is shown by the declaration of Peter Martyr to the effect that, if a wrong opinion should obtain regarding the creation as described in Genesis, "all the promises of Christ fall into nothing, and all the life of our religion would be lost." * Zwingli, broad as his views on other subjects generally were, was closely bound down in this matter, and held to the opinion of the Fathers, that a great floor separated the heavens from the earth, that above it were the waters and angels, and below it the earth and men. The only scope given to independent thought among the reformers was in a few minor speculations regarding the rivers which encompassed the paradise of Adam and Eve, the exact character of the conversation of the serpent with Eve, and the like. † And in the times immediately succeeding the Reformation matters went from bad to to worse. Under Luther and Melanchthon there was some little freedom of speculation, but under their successors there was none; to question any interpretation of Luther came to be thought almost as wicked as to question the literal interpretation of the Scriptures themselves. Examples of this are seen in the struggles between those who held that birds were created entirely from water and those who held that they were created out of water and mud. The accepted belief being that the "waters above the heavens" were contained in a vast receptacle upheld by a solid vault, when Calixt ventured, in interpreting the Psalms, to question this interpretation, he was bitterly denounced as heretical. ‡

Musæus, in the latter part of the sixteenth century, interpreted the account of Genesis to mean that "first God made the heavens for the roof or vault, and left it there on high swinging until three days later he put the earth under it." # In the city of Lubeck, the ancient center of the great Hanseatic League, close at the beginning of the seven-

other scholar found as much trouble from Mohammedan as his contemporaries found from Christian religion.

* See his commentary on Genesis, cited by Zöckler, "Geschichte der Beziehungen zwischen Theologie und Naturwissenschaft," vol. i, p. 690.

† See citations in Zöckler, vol. i, p. 693.

‡ See Zöckler, vol. i, p. 679.

See Musæus, "Auslegung des ersten Buchs Mosy," Magdeburg, 1576, cited by Zöckler, vol. ii, pp. 673-677, 761.

teenth century, Pfeiffer, "General Superintendent" or bishop in those parts, published a book entitled "Pansophia Mosaica," calculated, as he believed, to beat back science forever. In a long series of declamations he insisted that in the strict text of Genesis alone is safety; that it contains all wisdom and knowledge, human and divine; that twenty-eight articles of the Augsburg Confession are to be found in it; that it is an arsenal of arguments against all sects and sorts of "Atheists, Heathen, Jews, Turks, Tartars, Papists, Calvinists, Socinians, and Baptists"; the source of all sciences and arts, including law, medicine, philosophy, and rhetoric; "the source and essence of all histories and all professions, trades, and works"; "an exhibition of all virtues and vices"; "the origin of all consolation."* This being the case, who could care to waste time on the study of material things and give thought to the structure of the world? Above all, who, after such a proclamation by such a ruler in the Lutheran Israel, would dare to talk of the "days" mentioned in Genesis as "periods of time"; or of the "firmament" as not meaning a solid vault over the universe; or of the "waters above the heavens," as not contained in a vast cistern supported by the heavenly vault; or of the "windows of heaven" as a figure of speech?

In England the same spirit was shown even as late as the time of Sir Matthew Hale. We find in his book on the "Origination of Mankind," published in 1685, the strictest devotion to a theory of creation based upon the mere letter of Scripture, and a complete incapacity for the attainment of knowledge regarding the earth's origin and structure by any scientific process.

Still, while the Lutheran, Calvinistic, and Anglican reformers clung to literal interpretations of the sacred books, and turned their faces away from scientific investigation, it was among their contemporaries at the coming in of the modern period with the revival of learning that there began to arise fruitful thought in this field. Then it was, about the beginning of the sixteenth century, that Leonardo da Vinci, as great a genius in science as in art, broached the true idea as to the origin of fossil remains; and his compatriot, Fracastoro, developed this on the modern lines of thought. Others in other parts of Europe took up the idea, and, while mixing with it many crudities, evolved from it more and more truth. Toward the end of the sixteenth century Bernard Palissy, in France, took hold of it with the same genius which he showed in artistic creation; but, remarkable as were his assertions of scientific realities, they could gain little hearing. Theologians, philosophers, and even some scientific men of value, under the sway of scholastic phrases, insisted upon such explanations as that fossils were the product of "fatty matter set into a fermentation by heat"; or of a "lapidific juice";† or of a "seminal air";‡ or of a "tumultuous movement of terrestrial exhalations"; and there

* See Zöckler, vol. i, pp. 688, 689. † "Succus lapidificus." ‡ "Aura seminalis."

was a prevailing belief that fossil remains, in general, might be brought under the head of "sports of Nature," a pious turn being given to this phrase by the suggestion that these "sports" were in accordance with some inscrutable purpose of the Almighty.

Such remained a leading orthodox mode of explanation in the Church, Catholic and Protestant, for centuries.

But the better scientific method could not be entirely suppressed; and, near the beginning of the seventeenth century, De Clave, Bitaud, and De Villon revived it in France. Straightway, the theological faculty of Paris protested against the scientific doctrine as unscriptural, destroyed the offending treatises, banished their authors from Paris, and forbade them to live in towns or enter places of public resort.*

The champions of science, though repressed for a time, quietly labored on, and especially in Italy. Half a century later, Steno, a Dane, and Scilla, an Italian, went still further in the right direction; and, though they and their disciples took great pains to throw a tub to the whale, in the shape of sundry vague concessions based upon the book of Genesis, geological truth was more and more developed by them.

In France, the old theological spirit remained more powerful. At the middle of the eighteenth century Buffon made another attempt to state simple geological truths; but the theological faculty of the Sarbonne dragged him at once from his high position, forced him to recant ignominiously, and to print his recantation. This humiliating document reminds us painfully of that forced upon Galileo nearly a hundred years before. It runs as follows: "I declare that I had no intention to contradict the text of Scripture, that I believe most firmly all therein related about the creation, both as to order of time and matter of fact. I abandon everything in my book respecting the formation of the earth, and generally all which may be contrary to the narrative of Moses."

It has been well observed by one of the greatest of modern authorities that the doctrine which Buffon thus "abandoned" is as firmly established as the earth's rotation upon its axis.† Yet one hundred and fifty years were required to secure for it even a fair hearing; the prevailing doctrine of the Church continued to be that "in the beginning God made the heavens and the earth"; that "all things were made at the beginning of the world"; and that to say that stones and fossils were made before or since "the beginning" is contrary to Scripture. Again, we find theological substitutes for scientific explanation ripening into phrases more and more hollow, making fossils "sports of Nature," or "mineral concretions," or "creations of plastic force," or "models" made by the Creator before he had fully decided upon the best manner of creating various beings.

* See Morley, "Life of Palissy the Potter," vol. ii, p. 315, *et seq.*

† See citation and remark in Lyell's "Principles of Geology," chap. iii, p. 57.

Of this period, when theological substitutes for science were carrying all before them, there still exists a monument commemorating at the same time a farce and a tragedy. This is the work of Johann Beringer, professor in the University of Würzburg and private physician to the Prince-Bishop—the treatise bearing the title "Lithographiæ Wirceburgensis specimen primum," "illustrated with the marvelous likenesses of two hundred figured or rather insectiform stones." Beringer, for the greater glory of God, had previously committed himself so completely to the theory that fossils are simply "stones of a peculiar sort, hidden by the Author of Nature for his own pleasure," * that some of his students determined to give his faith in that pious doctrine a thorough trial. They therefore buried in a place where he was wont to search for specimens a store of sham fossils in baked clay—of their own manufacture—including not only plants, reptiles, and fishes of every sort that their knowledge or imagination could suggest, but even Hebrew and Syriac inscriptions, one of them the name of the Almighty. The joy of the pious professor on unearthing these proofs of the immediate agency of the finger of God in creating fossils knew no bounds. At great cost he prepared this book, whose twenty-two elaborate plates of *fac-similes* were forever to settle the question in favor of theology and against science. Prefixed to the work was an allegorical title-page, wherein not only the glory of his own sovereign, but that of heaven itself, was pictured as based upon a pyramid of these miraculous fossils. So robust was his faith that not even a premature exposure of the fraud could dissuade him from its publication. Dismissing in one contemptuous chapter this exposure as the slander of his rivals, he appealed to the learned world. But the shout of laughter that welcomed the work soon convinced even its author. In vain did he try to suppress it; and, according to tradition, having wasted his fortune in vain attempts to buy up all the copies of it, and, being taunted by the rivals whom he had thought to overwhelm, he died of chagrin. Even death did not end his misfortunes. The copies of the first edition having been sold by a graceless descendant to a Leipsic bookseller, a second edition was brought out under a new title, and this, too, is now much sought as a precious memorial of human folly.†

But even this discomfiture did not end the idea which had caused it, for, although some latitude was allowed among the various theologico-scientific explanations, it was still held meritorious to believe that all fossils were placed in the strata on one of the creative days by the

* See Beringer's "Lithographiæ," etc., p. 91.

† See Carus, "Geschichte der Zoologie," Munich, 1872, p. 467, note, and Reusch, "Bibel und Natur," p. 197. A list of the authorities upon this episode, with the text of one of the epigrams circulated at poor Beringer's expense, is given by Dr. Reuss in the "Serapeum" for 1852, p. 203. The book itself (the original impression) is in the White Library at Cornell University. For Beringer himself, see especially the encyclopædia of Ersch and Gruber, and the "Allg. deutsche Biographie."

hand of the Almighty, and that this was done for some mysterious purpose, probably for the trial of human faith.

Strange as it may at first seem, the theological war upon the true scientific method in geology was waged more fiercely in Protestant countries than in Catholic. The older Church had learned by her earlier wretched mistakes, especially in the cases of Copernicus and Galileo, what dangers to her claim of infallibility lay in meddling with a growing science. In Italy, therefore, comparatively little opposition was made, while England furnished the most bitter opponents to geology so long as the controversy could be maintained and the most active negotiators in patching up a truce on the basis of a sham science afterward. The Church of England did, indeed, produce some noble men, like Bishop Clayton and John Mitchell, who stood firmly by the scientific method; but these appear generally to have been overwhelmed by a chorus of churchmen and dissenters, whose mixtures of theology and science, sometimes tragic in their results and sometimes comic, are among the most instructive things in modern history.*

We have already noted that there are generally three periods or phases in a theological attack upon any science.† The first of these is marked by the general use of scriptural texts and statements against the new scientific doctrine; the third by attempts at compromise by means of far-fetched reconciliations of textual statements with ascertained fact; but the second or intermediate period between these two is frequently marked by the pitting against science of some great doctrine in theology. We saw this in astronomy when Bellarmin and his followers insisted that the scientific doctrine of the earth revolving about the sun is contrary to the theological doctrine of the incarnation. So now against geology it was urged that the scientific doctrine that fossils represent animals which died before Adam contradicts the theological doctrine of Adam's fall and the statement that "death entered the world by sin."

In this second stage of the theological struggle with geology, Eng-

* For a comparison between the conduct of Italian and English ecclesiastics as regards geology, see Lyell, "Principles of Geology," tenth English edition, vol. i, p. 33. For a philosophical statement of reasons why the struggle was more bitter and the attempt at deceptive compromises more absurd in England than elsewhere, see Maury, "L'ancienne Académie des Sciences," second edition, p. 152. For very frank confessions of the reasons why the Roman Catholic Church has become more careful in her dealings with science, see Roberts, "The Pontifical Decrees against the Earth's Movement," London, 1885, especially pp. 94 and 132, 133, and St. George Mivart's article in the "Nineteenth Century" for July, 1885. The first of these gentlemen is a Roman Catholic clergyman, and the second an eminent layman of the same church, and both admit that it was the Pope, speaking *ex cathedra*, who erred in the Galileo case; but their explanation is that God allowed the Pope and Church to fall into this grievous error, which has cost so dear, in order to show once and for all that the Church has no right to decide questions in science.

† See "The Warfare of Science," original edition, for a discussion of this point.

land was especially fruitful in champions of orthodoxy. First among these may be named Thomas Burnet. In the last quarter of the seventeenth century, just at the time when Newton's great discovery was given to the world, Burnet issued his "Sacred Theory of the Earth." His position was commanding; he was a royal chaplain and a cabinet officer of high standing. Planting himself upon the famous text in the second epistle of Peter,* he declares that the flood had destroyed the old and created a new world. The Newtonian theory he refuses to accept. In his theory of the deluge he lays less stress upon the "opening of the windows of heaven" than upon the "breaking up of the fountains of the great deep." On this latter point he comes forth with great strength. His theory is that the earth is hollow, and filled with fluid like an egg. Mixing together the texts in Genesis and in the second epistle of Peter, the theological doctrine of the "Fall," an astronomical theory regarding the ecliptic, and sundry notions caught from Descartes, he insisted that, before sin brought on the deluge, the earth was of perfect mathematical form, smooth and beautiful, "like an egg," with neither seas nor islands nor valleys nor rocks, "with not a wrinkle, scar, or fracture," and that all creation was equally perfect.

In the second book of his great work Burnet went still further. As in his first book he had mixed his texts of Genesis and St. Peter with Descartes, he now mixes the account of the Garden of Eden in Genesis with heathen legends of the golden age, and concludes that before the flood there was, over the whole earth, perpetual spring, disturbed by no rain more severe than the falling of the dew.

In addition to his other grounds for denying the earlier existence of the sea, he assigns the reason that, if there had been a sea before the Deluge, sinners would have learned to build ships, and so, when the Deluge set in, could have saved themselves.

The work was written with much power, and attracted universal attention. It was translated into various languages, and called forth a multitude of supporters and opponents in all parts of Europe. Strong men rose against it—especially in England—and among them a few dignitaries of the Church; but the Church generally hailed the work with joy. Addison praised it in a Latin ode, and for nearly a century it exercised a strong influence upon European feeling. It aided to plant more deeply than ever the theological opinion that the existing earth is now but a ruin; whereas, before sin brought on the Flood, it was beautiful in its "egg-shaped form," and free from every imperfection.

A few years later came another writer of the highest standing—William Whiston, professor at Cambridge, who in 1696 published his "New Theory of the Earth." Unlike Burnet, he endeavored to avail himself of the Newtonian idea, and brought in, to aid the geological

* See II Peter, iii, 6.

catastrophe caused by human sin, a comet, which opened "the fountains of the great deep."

But, far more important than either of these champions, there arose in the eighteenth century, to aid in the subjection of science to theology, three men of extraordinary power—John Wesley, Adam Clarke, and Richard Watson. All three were men of extraordinary intellectual gifts, the purest character, and the noblest purpose; and the first-named one of the greatest men in English history. Yet we find them in geology hopelessly fettered by the mere letter of Scripture, and by a temporary phase in theology. As in regard to witchcraft and the doctrine of comets, so in regard to geology, this theological view drew Wesley into enormous error.* The great doctrine which Wesley, Watson, Clarke, and their followers thought it especially necessary to uphold against geologists was, that death entered the world by sin—the first transgression of Adam and Eve. The extent to which the supposed necessity of upholding this doctrine carried Wesley seems now almost beyond belief. Basing his theology on the declaration that the Almighty after creation found the earth and all created things "very good," he declares in his sermon on the "Cause and Cure of Earthquakes," that no one who believes the Scriptures can deny that "sin is the moral cause of earthquakes, whatever their natural cause may be." Again, he declares that earthquakes are the "effect of that curse which was brought upon the earth by the original transgression." Bringing into connection with Genesis the declaration of St. Paul that "the whole creation groaneth and travaileth together in pain until now," he finds additional scriptural proof that the earthquakes were the result of Adam's fall. He declares, in his sermon on "God's Approbation of His Works," that "before the sin of Adam there were no agitations within the bowels of the earth, no violent convulsions, no concussions of the earth, no earthquakes, but all was unmoved as the pillars of heaven. There were then no such things as eruptions of fires; no volcanoes or burning mountains." Of course, a science which showed that earthquakes had been in operation for ages before the appearance of man on the planet, and which showed, also, that those very earthquakes which he considered as curses resultant upon the Fall were really blessings, producing the fissures in which we find to-day those mineral veins so essential to modern civilization, was entirely beyond his comprehension. He insists that earthquakes are "God's strange works of judgment, the proper effect and punishment of sin."

So, too, as to death and pain. In his sermon on the "Fall of Man" he takes the ground that death and pain entered the world by Adam's transgression, insisting that the carnage now going on among animals is the result of Adam's sin. Speaking of the birds, beasts,

* For his statement that "the giving up of witchcraft is in effect the giving up of the Bible," see Wesley's "Journal," 1766–'68.

and insects, he says that, before sin entered the world by Adam's fall, "none of these attempted to devour or in any way hurt one another"; that "the spider was then as harmless as the fly and did not then lie in wait for blood." * Here, again, Wesley arrayed his early followers against geology, which reveals, in the fossil remains of carnivorous animals, pain and death countless ages before the appearance of man. The half-digested fragments of weaker animals within the fossilized bodies of the stronger have destroyed all Wesley's arguments in behalf of his great theory.

Dr. Adam Clarke held similar views. He insisted that thorns and thistles were given as a curse to human labor, on account of Adam's sin, and appeared upon the earth for the first time after Adam's fall. So, too, Richard Watson, the most prolific writer of the great evangelical reform period, and the author of the "Institutes," the standard theological treatise in the evangelical army, says, in a chapter treating of the Fall, and especially of the serpent which tempted Eve: "We have no reason at all to believe that the animal had a serpentine form in any mode or degree until his transformation. That he was then degraded to a reptile, to go upon his belly, imports, on the contrary, an entire alteration and loss of the original form." All that admirable adjustment of the serpent to its environment which delights naturalists, was to Adam Clarke simply an evil result of the sin of Adam and Eve. Yet here again geology was obliged to confront theology in revealing the *python* in the Eocene—ages before man appeared. †

The immediate results of such teaching by such men was to throw many who would otherwise have resorted to observation and investigation back upon scholastic methods. Again reappears the old system of solving the riddle by phrases. In 1733, Dr. Theodore Arnold urged the theory of "models," and insisted that fossils result from "infinitesimal particles brought together in the creation to form the outline of all the creatures and objects upon and within the earth"; and Arnold's work translated into German gained wide acceptance. ‡

Such was the influence of this succession of great men that toward the close of the last century the English opponents of geology on biblical grounds seemed likely to sweep all before them. Cramping our whole inheritance of sacred literature within the rules of an historical compend, they showed the terrible dangers arising from the revelations of geology, which make the earth older than the six thousand years required by Archbishop Usher's interpretation of the Old Testament. Nor was this feeling confined to ecclesiastics. Williams, a thoughtful layman,

* See Wesley's sermon on "God's Approbation of His Works," 11th and 12th parts.

† See "Westminster Review," October, 1870, article on "John Wesley's Cosmogony," with citations from Wesley's "Sermons," Watson's "Institutes of Theology," Adam Clarke's "Commentary on the Holy Scriptures," etc.

‡ See citation in Mr. Ward's article, as above, p. 390.

declared that such researches led to infidelity and atheism, and are "nothing less than to depose the Almighty Creator of the universe from his office." The poet Cowper, one of the mildest of men, was also roused by these dangers, and in his most elaborate poem wrote:

"Some drill and bore
The solid earth, and from the strata there
Extract a register, by which we learn
That he who made it, and revealed its date
To Moses, was mistaken in its age!"

Howard summoned England to oppose "those scientific systems which are calculated to tear up in the public mind every remaining attachment to Christianity." *

While this great attack upon geological science by means of the dogma of Adam's fall was kept up, the more general attack by the literal interpretation of the text was continued. The legendary husks and rinds of our sacred books were insisted upon as equally precious and nutritious with the great moral and religious truths which they envelop. Especially precious were the six days—each "the evening and the morning"—and the exact statements as to the time when each part of creation came into being. To save these the struggle became more and more desperate.

Difficult as it is to realize it now, within the memory of many now living the battle was still raging most fiercely in England, and both kinds of artillery usually brought against a new science were in full play, and filling the civilized world with their roar.

About forty years ago, the Rev. J. Mellor Brown, the Rev. Henry Cole, and others, were hurling at all geologists alike, and especially at such Christian divines as Dr. Buckland and Dean Conybeare and Pye Smith, and such religious scholars as Professor Sedgwick, the epithets of "infidel," "impugner of the sacred record," and "assailant of the volume of God." †

The favorite weapon of the orthodox party was the charge that the geologists were "attacking the truth of God." They declared geology "not a subject of lawful inquiry," denouncing it as "a dark art," as "dangerous and disreputable," as "a forbidden province," as "infernal artillery," and as "an awful evasion of the testimony of revelation." ‡

This attempt to scare men from the science having failed, various other means were taken. To say nothing about England, it is humiliating to human nature to remember the annoyances, and even trials, to which the pettiest and narrowest of men subjected such Christian scholars in our own country as Benjamin Silliman and Edward Hitchcock and Louis Agassiz.

But it is a duty and a pleasure to state here that one great Chris-

* See Lyell, "Introduction."

† For these citations, see Lyell, "Principles of Geology," introduction.

‡ See Pye Smith, D. D., "Geology and Scripture," pp. 156, 157, 168, 169.

tian scholar did honor to religion and to himself by quietly accepting the claims of science and making the best of them, despite all these clamors. That man was Nicholas Wiseman, better known afterward as Cardinal Wiseman. The conduct of this pillar of the Roman Catholic Church contrasts admirably with that of timid Protestants, who were filling England with shrieks and denunciations.*

And here let me note that one of the most interesting skirmishes in this war was made in New England. Professor Stuart, of Andover, justly honored as a Hebrew scholar, declared that to speak of six periods of time for the creation was flying in the face of Scripture; that Genesis expressly speaks of six days, each made up of "the evening and the morning," and not six periods of time.

To him replied a professor in Yale College, James Kingsley. In an article admirable for keen wit and kindly temper, he showed that Genesis speaks just as clearly of a solid firmament as of six ordinary days, and that, if Professor Stuart had got over one difficulty and accepted the Copernican theory, he might as well get over another and accept the revelations of geology. The encounter was quick and decisive, and the victory was with science and our own honored Yale.†

But perhaps the most singular attempt against geology was made by a fine specimen of the English Don—Dean Cockburn, of York—to *scold* its champions out of the field. Having no adequate knowledge of geology, he opened a battery of abuse. He gave it to the world at large by pulpit and press; he even inflicted it upon leading statesmen by private letters.‡ From his pulpit in York Minster, Mary Somerville was denounced coarsely, by name, for those studies in physical geography which have made her honored throughout the world.#

But these weapons did not succeed; they were like Chinese gongs and dragon-lanterns against rifled cannon, and we are now to look at a very different chapter in this war. This chapter will form the next subject of our study.

* Wiseman, "Twelve Lectures on the Connection between Science and Revealed Religion," first American edition, New York, 1837. As to the comparative severity of the struggle regarding astronomy, geology, etc., in Catholic and Protestant countries, see Lecky, "England in the Eighteenth Century," chap. ix, p. 525.

† See "Silliman's Journal," vol. xxx, p. 114.

‡ Professor Goldwin Smith informs me that the papers of Sir Robert Peel, yet unpublished, contain very curious specimens of these epistles.

See "Personal Recollections of Mary Somerville," Boston, 1874, pp. 139 and 375. Compare with any statement of his religious views that Dean Cockburn was able to make, the following from Mrs. Somerville: "Nothing has afforded me so convincing a proof of the Deity as these purely mental conceptions of numerical and mathematical science which have been, by slow degrees, vouchsafed to man—and are still granted in these latter times by the differential calculus, now superseded by the higher algebra—all of which must have existed in that sublimely omniscient mind from eternity." (See "Personal Recollections," pp. 140, 141.)

PROGRESS AT PANAMA.

By CHARLES C. ROGERS,
LIEUTENANT, UNITED STATES NAVY.

ON the 6th of last March the United States steamer Galena reached Aspinwall after a cruise in the Windward and the Leeward Islands. Before her departure from Norfolk in January, I was directed by the Navy Department to visit the works of the canal upon our arrival at Aspinwall. M. Charles de Lesseps, accompanied by M. Romaire, his secretary, M. Cottu, administrator of the canal, and by other officials from the general office in Paris, with M. Jacquier, director-general of the works, were then occupying the handsome residence in the French quarter of Aspinwall, that is usually assigned to the president of the company during his visits to the Isthmus. They had arrived from France five days before the Galena from the Spanish Main, and were to inspect the canal and arrange with the contractors for the future progress of the works. On the 9th I called upon M. de Lesseps and the director-general, stated my instructions from the Navy Department, and requested permission to visit the canal and to obtain from the contractors full information concerning their respective fields of work. My reception by these gentlemen was most cordial, and was appreciated particularly as an extension of hospitality and civility to an officer of the United States Navy. M. de Lesseps assented readily to my request, assuring me that there was nothing to conceal, and that it was the wish of the company that our Government should know the exact condition of the works and their prospects of completion. He also invited me to accompany him as his guest during his tour of inspection. On reporting the result of my visit to Commander Colby M. Chester, commanding the Galena, I was permitted to accept the invitation so kindly extended.

M. de Lesseps had inspected the 17 kilometres of canal open to water, and on the 10th I proceeded with him by special train to Bohio-Soldado, reserving my visit to the sections of Colon and Gatun for a later date. The inspection thus begun lasted nearly three weeks. I saw every foot of the canal, including the dam at Gamboa and the deflections of the Chagres and the Rio Grande.

Its length from Colon to the Isle of Naos, near Panama, will be 74 kilometres; its width at the surface will be 40 metres, and at the bottom 22 metres; its depth will be 9 metres. The line of works is separated into five divisions, the first of which is 26·35 kilometres in length, and comprises the sections of Colon, Gatun, and Bohio-Soldado. It is under the control of the American Contracting and Dredging Company, which owns a capital of \$2,000,000. Mr. H. B. Slaven is president of the company, and Mr. M. A. Slaven general manager on the Isthmus. Messrs. Vignaud, Barbaud, Blanleuil & Co. have the second division, which includes the Tavernilla, San Pablo, Gorgona, and Matachin sections, and is 17·65 kilometres long. They have built several railways in France, and are experienced in the construction of internal canals. The third falls to the Société de Travaux Publics et Constructions, which has a capital of $600,000, and is known in France and Brazil for successful railway work; it consists of the sections of Obispo and Emperador, and is 9·6 kilometres long. The fourth, or section of Culebra, extends over 3·4 kilometres, and is controlled by the young and energetic firm of Artigue, Sonderegger & Co.; and Messrs. Baratoux, Letellier & Co. have agreed to open the last division to the waters of the Pacific within the next two years. It is 17 kilometres long, and extends from the Culebra to Panama. The company has also established three *physical* divisions, each with reference to the engineering problems involved. The first is 44 kilometres long, and extends from Colon to the Gamboa hills at Matachin, the difficulty lying in the vicinity of the Chagres. The second lies between Gamboa and the end of the Culebra; it contains the highest summits and the greatest quantity of rock, and it will be the line of deepest cuts. The third extends from the Culebra to the Pacific; here the earth will admit of dredging throughout, but the Rio Grande must be deflected from the line of the canal.

The first division begins at Colon with a terre-plein that was formerly the site of a marsh, containing 236,000 cubic metres of earth, and surrounded by a sea-wall; the terre-plein protects the entrance of the canal from the waves that would enter otherwise from the Bay of Limon. It is the site also of the village of Christoval-Colon, where the offices and quarters of the section employés are found.

As the Bay of Limon is exposed to the sea and to the gales of this region, the company is making a new harbor, which is styled the port of Colon. It lies south of the terre-plein, and, when complete, will be formed by Fox River and the expansion of the first 3 kilometres of the canal into a basin. The width of the entrance will be 800 metres; thence to the six-hundredth metre of length, the breadth of the basin will decrease to 500 metres, and will remain uniform as far as the second kilometre, whence it will narrow gradually to the third, where the normal surface width of 40 metres begins. A curved breakwater of 1,500 metres length will prolong the right bank into the bay, and will further protect the port from winds and waves. The new port will afford security to vessels and every facility of wharfage for handling cargo.

The canal is open to water as far as the seventeenth kilometre from Colon, except at the Mindi hills, where a cut of 1,080 metres remains to be completed. Its width for the first 500 yards is 225 metres; throughout the remainder of the basin it varies from 175 to 80 metres, and finally narrows to the normal at the third kilometre. The delay in opening the Mindi cut is due to the wish to complete the excavation of rocks, and thus render submarine blasting unnecessary. Of the eleven dredges at work in this division, four are European, and vary from 60 to 180 horse-power; the remaining seven are American, of 240 horse-power, their maximum capacity of excavation being 6,000 cubic metres per day. But repairs to machinery, rains, stoppage during the extreme heat of the day and at night, and other delays that can not be remedied, have reduced the daily yield to 3,000 cubic metres.

The level of the remaining bed of the first division is from 4 to 10 metres above the sea. Part of a hill near Bohio remains at the elevations of 20 and 28 metres.

The Chagres is both the upper and the lower limit of the second division, and crosses it seventeen times in its length of 17 kilometres. The average level is 12 metres above the sea, except in a single hill of 25 metres height and in a sudden rise to the same elevation at the end of the division. The excavators are moved on railway-tracks by an engine of 8 to 10 horse-power, and empty their buckets into cars on adjacent rails. Every facility for dredging is presented by the Chagres River, the depth of which is such that dredges can be put at each crossing.

Just within the third division is the Gamboa hill, where occurred the great explosion of 1886 in honor of M. Ferdinand de Lesseps. The charge was 8,250 pounds of dynamite and powder, and blew out 30,000 cubic metres of material. Farther on is the Corrosita, still 45 metres above the sea. But the most remarkable feature of the division is the great *barrage* at Gamboa. Its central line will cross the Chagres between the Cerro Obispo and the Cerro Santa Cruz. Its length at the base will be 300 metres, its height 35 metres, and, with a reveted slope of four to one, it will contain 10,000,000 cubic metres of rock and clay. No excavation is needed for the foundation; a bridge is now building across the valley, and from it trains will discharge into the valley below their loads of rock and earth excavated from the Corrosita and neighboring sections. The pressure of water in the basin will seal the dam by forcing the clay into the interstices of the rock-mass, and by deposits brought down by the river. The capacity of the basin will be one billion cubic metres, or double the accumulation of waters during the worst rainy season. Nature has furnished the other walls of this reservoir in the ridges on each side of the Chagres, and in the natural ascent of the valley toward Cruces. The outlet of the basin will be a derivation of the Chagres around the hills of Barucco and Carga-Plata to the bend north of the forty-fourth kilometre; the outflow will depend upon the height of the water in the basin, but it will never be such that, when coupled even with the drainage of the remaining water-shed of the Upper Chagres, floods can occur in the lower course of the river.

In the last days of November the water usually rises to eight metres above the ordinary level. In the valley of the Chagres the annual rainfall is 3 metres. The average discharge of the river during the wet season is 134 cubic metres per second, and 666 during the floods. In the exceptional rise of 1879 it reached 1,930 cubic metres, but it must be remembered that such discharges seldom last more than forty-eight hours; for, as Lieutenant Kimball states in his valuable report just published, "The floods are of short duration, showing that they result from large local rainfall, and not from extensive watershed." When the *barrage* and derivations are completed, I believe that the problem of the Chagres will be solved.

Another interesting feature of this division is the two aqueducts that will be built near Emperador to carry the waters from the mountain valleys on the northern and eastern side across the canal into the Obispo River. Their elevation will be the present levels of these sites, and vessels will pass under them. The bed of the cuttings at the end of the division have now a level of 55 metres.

The original elevation of the Culebra in the plane of the axis of the canal was 108 metres; the cuttings have reduced it to 78 metres. The width of the cut at the summit is 300 metres, the slope of the sides being forty-five degrees. But a serious question at this point lies in the accumulation of material by wash, land-slides, and fissures. Last year 78,000 cubic metres of earth fell into the canal. The hill on the right side of the cut is formed of dolerite and sand, and no wash or slip can occur from it. But on the left side I found strata of clay covered with a mixture of alluvium, sand, and conglomerate. During the wet season this deposit becomes saturated, and the increased weight, coupled with the dip of the strata, causes it to slip over the smooth surface of the clay into the canal. The clay in turn contracts during the dry season, fissures result, and hence another source of land-slides; and the natural wash of torrential rains is a third cause of deposit in the bed of the cut.

But a far more serious problem apparently is the annual movement of this side toward the axis of the canal. It varies from 12 to 18 inches, and the contractors acknowledge that its remedy may require heavy expenditure for increased slope, if nothing more. As yet, however, this can not be regarded as an *actual* danger. The removal of so much material from the Culebra must affect the position of the center of gravity of the mass, and it may be that this movement results from a settling to the new conditions. This is the more hopeful view, and a reasonable one, but there is greater cause to fear that this is a movement of the whole hill-side, and not an earth-slide from the higher portions of the bank. The clay of Culebra is of the same bed as the "greasy" or slipping clay of the adjoining section of Paraiso. Referring to the latter, Lieutenant Kimball says its movement "in some places carries one bank almost intact across the cut with the top surface unbroken, and with the vegetation undisturbed." Again, "The effect of the move of the soil was very curious; at one point the bottom of the deflection cut had *risen* 3 metres where the greasy clay had forced itself underneath, and at another I saw a surveying picket which had moved *out of line* 2½ metres, where there was no break in the top soil." To my mind, the deep cut of the Culebra is the great problem of the enterprise; already its side threatens to bar the way.

Leaving this puzzle to the contractors, and looking toward Panama, the first third of the last division descends gradually to 4 metres level at Pedro Miguel; the middle portion forms a plane from 5 to 8 feet above the sea, and over the last 6 kilometres flow the waters of the Pacific to an average depth of 5 metres, and reaching the maximum as Naos is approached.

At Colon the highest tides do not exceed 58 centimetres, or 23 inches, while at Panama high tides reach 4 metres, or 13 feet, and spring tides even 6 metres, or 20 feet. That vessels may pass at all stages of tide, the depth of the canal from Naos to the present crossing of the Rio Grande beyond Corozal—9·4 kilometres—will be 9 metres at lowest ebb.

The company has consulted the French Academy of Sciences concerning the probable effect of this difference of tide-level on the canal, and has been told that a lock or tidal gate will not be needed. The director-general does not oppose this view, but thinks that an answer to this question at present must be based on theory—that, as excavations progress, the effect must be watched; and that upon the knowledge obtained the decision must rest. Plans for a tidal gate have been prepared, and, if needed, it will be placed at the Boca, near Panama.

The line of the canal is crossed twenty-eight times by the Chagres between Gamboa and Colon, and thirteen times by the Rio Grande between Culebra and Panama. To avoid the dangers of current and overflow that would exist if these streams entered the canal, deflections are excavated to carry them to the sea in beds on each side of the canal. The deflections of the Upper Chagres will drain the Gamboa basin and the water-shed north of the canal, and will discharge their waters into the Boca Grande, east of Colon; those of the Lower Chagres will transport to the present mouth of the Chagres, the tributaries now entering the river on its left bank, the most important of which are the Obispo, the Arena, and the Trinidad. The Rio Grande will be deflected entirely to the right of the canal, and will enter the sea at La Boca. The total length of the deflections will be 64 kilometres. Some of them will be 40 metres wide and 3 deep; others, 30 metres wide and 5 deep. Erosion will increase these dimensions. Lying in valleys where feasible, the soil is alluvial, and easily excavated. It has occasionally happened that a subterranean stream has undermined the banks, and caused a break. The engineers claim that so far the repairs are effective, and I see no cause to disagree with them.

The following table shows the total excavation in both canal and derivations. The figures are those of the Canal Company, expressed in cubic metres:

SECTIONS.	CANAL.			DEFLECTIONS.		
	Original cube.	Cube excavated.	Cube remaining.	Original cube.	Cube excavated.	Cube remaining.
Colon	2,500,000	1,900,000	600,000	600,000	420,000	180,000
Gatun	6,300,000	5,300,000	1,000,000	3,000,000	2,600,000	400,000
Bohio	5,500,000	2,100,000	3,400,000	1,100,000	450,000	650,000
Tavernilla	6,000,000	500,000	5,500,000	1,200,000	100,000	1,100,000
San Pablo	4,000,000	1,200,000	2,800,000	900,000	90,000	810,000
Gorgona	4,500,000	1,600,000	2,900,000	850,000	260,000	590,000
Matachin	3,250,000	1,200,000	2,050,000	400,000	150,000	250,000
Obispo	10,000,000	3,100,000	6,900,000	900,000	90,000	810,000
Emperador	19,000,000	4,300,000	14,700,000	500,000	....	500,000
Culebra	23,000,000	2,100,000	20,900,000	None.	....	....
Paraiso	7,000,000	1,800,000	5,200,000	240,000	180,000	60,000
Corozal	1,600,000	400,000	1,200,000	150,000	100,000	50,000
La Boca	2,500,000	1,900,000	600,000	100,000	80,000	20,000
Total	95,150,000	27,400,000	67,750,000	9,940,000	4,520,000	5,420,000

According to these statistics the total cube of canal and deflections was 105,090,000 cubic metres; the amount excavated is 31,920,000 cubic metres, leaving 73,170,000 to be removed. In other words, thirty per cent of the work is finished, and seventy per cent remains. The deflections are nearly half finished. The principal machine-shops are at Colon, Matachin, and Panama. These, with the hospitals and quarters for officials and laborers, if placed side by side, would cover an area of eighty-one acres. They are frame-buildings, picturesquely situated, with sills resting on masonry supports, and roofs of corrugated iron. They are clean, well-ventilated, and admirably suited to the climate of the Isthmus. The "cantines" are kept by Chinamen, who board the laborers at reasonable rates. The native huts are unhealthy; the vegetable matter of a thatched roof decays and becomes a harbor for insects. The present quarters are decidedly in the line of economy both as regards health and future expense and needs. I visited the Isthmus in 1881, when the country was a thickly-matted jungle, the only signs of habitation being a few huts at railway-stations. To-day thousands of acres are cleared, and such is the installation of the company that the canal seems to lie in a prosperous and populous district. In fact, the passenger from Matachin to Culebra is reminded rather of a single settlement than of several railway-stations.

At the time of my visit 10,640 workmen were employed by the contractors; with the 926 employés of the company, the total force was 11,566 men. The laborers are chiefly negroes from Jamaica or other islands, with a few from our Southern States, who have gone to Colon in coasting-vessels, and have been attracted by the wages of $1.50 per day in Colombian coin. About 300 Kroomen and as many

Chinese recently brought over, have shown themselves good workmen. Time contracts are unknown ; Government officials in the islands discourage negro emigration to the Isthmus ; and changes are arising constantly from sickness, dissipation, return to homes, or fear of revolution. Many leave through fear of climate, lack of guaranteed hospital attendance, and the exorbitant rates of the Isthmus.

On Saturday the laborers are paid. Sunday is spent in dissipation or pleasure, Monday in recuperation, and it is not till Tuesday that a full force is at work ; hence the number of working-days in a month seldom exceeds twenty or twenty-two. Twenty thousand laborers are wanted ; and as the West Indies do not supply them, the company is trying to solve the difficult question of labor in the populations of Western Africa and Southern China.

The main hospitals are at Colon and Panama, but physicians are assigned also to each section of the works. There is, too, a sanitarium on Taboga, an island fourteen miles from Panama. The entire medical staff consists of thirty physicians and fifty apothecaries. It must be increased and other hospitals provided, if additions be made to the force of laborers. The hospital service has been much criticised, and it has been asserted that contractors discharge the sick, who die for lack of medical attendance. During my stay of six weeks on the Isthmus I saw nothing to confirm such statement. The hospital records show a death-rate of seven per cent to January, 1887 ; but this does not include those who, on account of illness or disease contracted here, have left and died elsewhere.

In the original act of concession, Colombia agreed to surrender to the Canal Company a border 200 metres wide on each side of the canal, and 500,000 hectares (1,235,571 acres) of public lands as the work progresses. The first grant of 150,000 hectares, made when the Colombian Government conceded that one third of the total work necessary for the construction of the canal had been done, is situated near the Chiriqui Lagoon and along the Tuira River. Besides this, the company has bought 34,653 acres between Colon and Panama. On the 9th of October, 1886, the first grant was increased to 250,000 hectares, the Government conceding that one half of the necessary work had been finished. The company owns, therefore, 652,438 acres of land, besides the border of 200 metres on each side of the canal.

By this, however, neither the Government nor the company concede that one half of the necessary excavation has been made ; but that the present excavation, plus the quarters for officials and workmen, the hospitals, and the plant of machinery, represents one half of the total work required to finish the canal. Undoubtedly, quarters and machinery are important factors of the total work, but they do not represent twenty per cent of it ; the Government would be sufficiently liberal in conceding to-day that one third of the total work has been done.

In 1870 the traffic of the Suez Canal was represented by 486 ships of 435,911 tons, yielding a revenue of 5,159,327 francs; in 1885 it was 3,624 vessels, of 8,985,411 tons, and paying 62,207,439 francs. M. Levasseur, Member of the Institute, taking the statistics of 1876 as a basis, estimates that if the canal were open in 1889, the tonnage of vessels passing through it would be 7,250,000. M. Marteau, editor of the "Journal du Havre," places it at 9,000,000 tons. Both gentlemen disregard the markets of the Mediterranean and of India, and send the entire commerce of Western Europe through the Panama Canal during the first year of its existence. Presuming a tariff of fifteen francs per ton, the receipts from either estimate would not remunerate at the outset a capital exceeding $240,000,000, when expenses of administration and repair are deducted. On the 1st of last March the total sum realized from the company's loans was $179,771,190. As a new loan has since been raised, this sum must be wholly expended. It is evident that the final cost will exceed the sum warranted by the estimates.

No exact estimate of the time and money required to finish the canal can be made, as much of the data needed is unknown. M. Charles de Lesseps said to me: "In two years the canal will be finished from Colon to kilometre forty-four, and from La Boca to Paraiso. As to the Culebra, I leave you to form your own conclusions. It is a great and difficult work."

It is evident that the rate of excavation in a work of such magnitude must be small until the plant is complete; it is equally true that more work can be done in a given time with a complete installation than with one of less size. Hence it is false reasoning to conclude that if 32,000,000 cubic metres are excavated in five years, it will require twelve years to extract the remaining 73,000,000. That such reasoning is absurd is shown by the cube of last year, which was 11,727,000 cubic metres. At this rate it would require about seven years to complete the canal. It is not probable that this rate will be exceeded materially for a year or more.

Keeping in mind the sum already expended, and the purposes to which it was applied, it is unreasonable to presume that the final cost of the canal will be less than 2,000,000,000 francs, or about $375,000,000. These figures are now acknowledged by the company; but owing to the great sacrifice at which the loans are obtained, the liabilities of the company will be nearly double this amount.

Any views concerning the completion of the canal by the present company must be conjectural; but if the present loan be expended with economy, the results will enhance the prospects of success.

At Colon there were many residents and foreigners not interested in the canal. The most bitter opponents of the enterprise were Americans and Englishmen, or former employés of the company who had been discharged or had a similar grievance. But from all sources there was a free admission that the company has both brains and energy,

PANAMA CANAL.

GENERAL PLAN

Dredged and now open to water.

Reserved for dredges.

Deflections.

In course of preparation for dredges.

Earth removed by excavators.

Dimensions of Canal:

Width on bottom — 22 metres

Width at surface — 40 "

Depth — 9 "

that the canal presents no insuperable obstacles, and that its completion is a question of time and money.

Addenda.—In a report dated September 1st, Señor Armero, agent of the Colombian Government, estimates the whole sum required to finish the canal at 3,012,495,400 francs, equal to $602,639,080. This fabulous sum he believes will be raised because so many millions are already sunk in the work, and half a million holders of stocks and bonds are interested, and the honor of France is at stake. But at the rate of progress so far attained the work can not be completed, nor can even the temporary canal, with locks, etc., now proposed by M. de Lesseps, be opened to traffic in 1889 or even in 1892, the year in which the concession terminates.

The proposed plan of M. de Lesseps is to excavate the 60 kilometres of lower elevations by present methods, and to form a lake of the 14 kilometres of central mass, to be reached on both the Pacific and the Atlantic sides by locks. By this means he proposes to finish the temporary canal by 1890 at a cost of 1,500,000,000 francs. The temporary canal completed, dredges will continue their work in the lake and gradually deepen the channel till a sea-level canal shall be formed from ocean to ocean.

THE ECONOMIC OUTLOOK—PRESENT AND PROSPECTIVE.

By Hon. DAVID A. WELLS.

ECONOMIC DISTURBANCE SERIES, No. VIII.

PART I.

THE predominant feeling induced by a review and consideration of the numerous and complex economic changes and disturbances that have occurred since 1873 (as has been detailed in the foregoing papers of this series), is undoubtedly, in the case of very many persons, discouraging and pessimistic. What many think but hesitate to say, finds forcible expression in the following extract from a letter addressed to the writer by a large-hearted, sympathetic man, who is at the same time one of the best known of American journalists and leaders of public opinion. After referring to his great interest in the general subject, he says:

> But what a deplorable and quite awful picture you suggest of the future! The wheel of progress is to be run over the whole human race and smash us all, or nearly all, to a monstrous flatness. I get up from the reading of the articles scared, and more satisfied than ever before that the true and wise course of every man is to get somewhere a piece of land, raise and make what he can for himself, and try thus to get out of the crushing process. It seems to me that what we call civilization is to degrade and incapacitate the mass of men and women; and how strange and incongruous a state it is. At the same time these masses of men are thrown out of their accustomed employments by the introduction or

perfection of machinery—at that very time the number of women and children employed in factories rapidly increases; an unprecedented cheapness of all necessaries of life is coincident with an intensification of the bitter struggle for bread and shelter. It is a new form of slavery which, it seems to me, projects itself into view—universal slavery—not patriarchal, but mercantile. I get yearly more tired of what we call civilization. It seems to me a preposterous fraud. It does not give us leisure; it does not enable us to be clean except at a monstrous cost; it affects us with horrible diseases—like diphtheria and typhoid fever—poisoning our water and the air we breathe; it fosters the vicious classes —the politicians and the liquor-sellers—so that these grow continually more formidable, and it compels mankind to a strife for bread, which makes us all meaner than God intended us to be. Do you really think the "game pays for the candle"?

A review of the causes of the recent economic disturbances in which sympathetic sentiments are allowed to predominate, is not, however, what is needed for estimating their present and future influence; but rather a review which will array and consider the facts and the conclusions which can be fairly deduced from them, apart, if possible, from the slightest humanitarian predisposition. The surgeon's probe that trembles in sympathy with the quivering flesh into which it penetrates, is not the instrumentality best adapted for making a correct diagnosis.

In attempting such a review the first point worthy of attention is, that with the exception of a change unprecedented in modern times —in the relative values of the precious metals—all that has occurred differs from the world's past experience simply in *degree* and not in *kind*. We have, therefore, no absolutely unknown factors to deal with; and if the record of the past is not as perfect as could be desired—for it is only within a comparatively recent period that those exact statistics which constitute the foundations and absolute essentials of all correct economic reasoning have been gathered—it is, nevertheless, sufficiently so to insure against the commission of any serious errors in forecasting the future, of what in respect to industry and society is clearly a process of evolution. This evolution exists in virtue of a law of constant acceleration of knowledge among men of the forces of Nature, and in acquiring a capacity to use them for increasing or supplementing human effort, for the purpose of increasing and cheapening the work of production and distribution. There is, furthermore, no reason for doubting that this evolution is to continue, although no one at any one time can foretell what are to be the next phases of development, or even so much as imagine the ultimate goal to which such progress tends. The ignorance, prejudice, and selfishness of man may operate in the future, as in the past and at present, in obstructing this progress; but to entirely arrest it, or even effect a brief retrogression, would seem to be utterly impossible.*

* Those persons whose business renders them most conversant with patents, are the ones most sanguine, that nothing is likely to occur to interrupt or even check, in the immediate future, the progress of invention and discovery.

The questions which naturally next suggest themselves, and in fact are being continually asked, are: Is mankind being made happier or better by this progress? or, on the contrary, is not its tendency, as Dr. Siemens, of Berlin, has expressed it, "to the destruction of all of our ideals and to coarse sensualism; to aggravate injustice in the distribution of wealth; diminish to individual laborers the opportunities for independent work, and thereby bring them into a more dependent position; and, finally, is not the supremacy of birth and the sword about to be superseded by the still more oppressive reign of inherited or acquired property?"

That many of the features of the situation are, when considered by themselves, disagreeable and even appalling, can not be denied. When one recalls, for example, through what seemingly weird power of genius, machinery has been summoned into existence—machinery which does not sleep, does not need rest, is not the recipient of wages; is most profitable when most unremittingly employed—and how no one agency has so stimulated its invention and use as the opposition of those whose toil it has supplemented or lightened—the first remedial idea of every employer whose labor is discontented being to devise and use a tool in place of a man;* and how in the place of being a bond-slave it seems to be passing beyond control and assuming the mastery; when one recalls all these incidents of progress, the following story of Eastern magic might be almost regarded in the light of a purposely obscured old-time prophecy. A certain man, having by great learning obtained knowledge of an incantation whereby he could compel inanimate objects to work for him, commanded a stick to bring him water. The stick at once obeyed. But when water sufficient for the man's necessities had been brought, and there was threatened danger of an oversupply, he desired the stick to stop working. Having, however, omitted to learn the words for revoking the incantation, the stick refused to obey. Thereupon, the magician in anger caught up

* The following is one striking illustration in proof of this statement: After the reaping-machine had been perfected to a high degree, and had come into general use in the great wheat-growing States of the Northwest, the farmer found himself for ten or fifteen days during the harvest period at the mercy of a set of men who made his necessity for binding the wheat concurrently with its reaping, their opportunity. They began their work in the southern section of the wheat-producing States, and moved northward with the progress of the harvesting; demanding and obtaining \$2, \$3, and even \$4 and upward, per day, besides their board and lodging, for binding; making themselves, moreover, at times very disagreeable in the farmers' families, and materially reducing through their extravagant wages the profits of the crop. An urgent demand was thus created for a machine that would bind as well as reap; and after a time it came, and now wheat is bound as it is harvested, without the intervention of any manual labor. When the sheafs were first mechanically bound, iron wire was used as the binding material; but when a monopoly manufacturer, protected by patents and tariffs, charged what was regarded an undue price for wire, cheap and coarse twine was substituted; and latterly a machine has been invented and introduced, which binds with a wisp of the same straw that is being harvested.

an axe, and, with a view to diminish or destroy the power of the stick to perform work, chopped it into several pieces; whereupon, each piece immediately began to bring as much water as one had formerly done; and in the end not only the magician but the whole world was deluged and destroyed.

The proposition, that "all transitions in the life of society, even those to a better stage, are inevitably accompanied by human suffering," is undoubtedly correct. It is impossible, as an old-time writer (Sir James Stewart, 1767) has remarked, to even sweep a room without raising a dust and occasioning temporary discomfort. But those who are inclined to take discouraging and pessimistic views of recent economic movements, seem not only to forget this, but also to content themselves with looking mainly at the bad results of such movements, in place of the good and bad together. So it is not difficult to understand how a person like the Russian novelist Tolstoi, a man of genius, but whose life and writings show him to be eccentric almost to the verge of insanity, should, after familiarizing himself with peasant life in Russia, come to the conclusion "that the edifice of civil society, erected by the toil and energy of countless generations, is a crumbling ruin." But the trials and vicissitudes of life as Tolstoi finds them among the masses of Russia are the result of an original barbarism and savagery from which the composite races of that country have not yet been able to emancipate themselves; coupled with the existence of a typically despotic government, which throttles every movement for increased freedom in respect to both person and thought. But these are results for which the higher civilization of other countries is in nowise responsible and can not at present help, but the indirect influence of which will, without doubt, in time powerfully affect and even entirely change. No one, furthermore, can familiarize himself with life as it exists in the slums and tenement-houses of all great cities in countries of the highest civilization; or in sterile Newfoundland, where all nature is harsh and niggardly; or in sunny Mexico and the islands of the West Indies, where she is all bountiful and attractive, without finding much to sicken him with the aspects under which average humanity presents itself. But even here the evidence is absolutely conclusive that matters are not worse, but almost immeasurably better than formerly; and that the possibilities for melioration, through what may be termed the general drift of affairs, is, beyond all comparison, greater than at any former period.

The first and signal result of the recent remarkable changes in the conditions of production and distribution, which in turn have been so conducive of industrial and societary disturbances, has been to greatly increase the abundance and reduce the price of most useful and desirable commodities. If some may say, "What of that, so long as distribution is impeded and has not been correspondingly perfected?" it may be answered, that production and distribution in virtue of a natural law are correlative or reciprocal. We produce to consume, and we consume to produce, and the one will not go on independently of the other; and although there may be, and actually is, and mainly through the influence of bad laws, more or less extensive mal-adjustment of these two great agencies, the tendency is, and by methods to be hereafter pointed out, for the two to come closer and closer into correspondence.

Next in order, it is important to recognize and keep clearly in view in reasoning upon this subject, what of good these same agencies, whose influence in respect to the future is now regarded by so many with alarm or suspicion, have already accomplished.

A hundred years ago the maintenance of the existing population of Great Britain, of the United States, and of all other highly-civilized countries, could not have been possible under the then imperfect and limited conditions of production and distribution. Malthus, who in 1798 was led by his investigations to the conclusion that the population of the world, and particularly of England, was rapidly pressing upon the limits of subsistence, and could not go on increasing because there would not be food for its support, was entirely right from his standpoint on the then existing economic conditions; * and no society at the present time, no matter how favorable may be its environments in respect to fertility of land, geniality of climate, and sparseness of population, is making any progress except through methods that in Malthus's day were practically unknown. The Malthusian theory is, moreover, completely exemplifying itself to-day in India, which is densely populated, destitute in great degree of roads, and of the knowledge and use of machinery. For here the conditions of peace established under British rule are proving so effective in removing the many obstacles to the growth of population that formerly existed, that its increase from year to year is pressing so rapidly on the means of subsistence, that periodical famines, over large areas, and accompanied with great destruction of life, are regarded as so inevitable that the creation of a national famine fund by the Government has been deemed necessary.†

* "Malthus made no prediction in the strict sense of the word. He had drawn out from experience that the human race tended to increase faster than the means of subsistence; its natural increase being in geometrical ratio, and the increase of its means of subsistence an arithmetical one; so that population had been kept down only in past times by war and famine, and by disease as the consequence of famine. He was bound to anticipate that a continuance of the process would expose the race once more to the operation of these natural checks, or to a descent of the masses in the scale of living, or to both of these evils. That the new experience has been different from the former one, and that owing to various causes the means of subsistence have increased faster than the population, even when increasing at a Malthusian rate, is no disproof surely of the teaching of Malthus. His statistical inquiries into the past remain as valuable as ever."—"*Some General Uses of Statistical Knowledge.*" ROBERT GIFFEN, *Royal Statistical Society of England, 1885.*

† The present condition of India constitutes one of the most curious and interesting

Illustrations confirmatory of the assertion that the food resources of half a century ago would be inadequate for the support of the existing population of the leading civilized countries are familiar, but the following are so striking as to warrant renewed presentation :

All the resources of the population of the United States, as they existed in 1880, would have been wholly inadequate to have sowed or harvested the present average annual corn or wheat crops of the country ; and, even if these two results had been accomplished, the greater proportion of such a cereal product would have been of no value to the cultivator, and must have rotted on the ground for lack of any means of adequate distribution ; the cost of the transportation of a ton of wheat, worth twenty-five dollars at a market, for a distance of a hundred and twenty miles over good roads, and with good teams and vehicles, entirely exhausting its initial value.

Forty years ago corn (maize) was shelled in the United States by scraping the ears against the sharp edge of a frying-pan or shovel, or

economic and social problems of the last quarter of the nineteenth century. While the general average of the population for the whole country is 184 to the square mile, there are districts in India in which a population, to be counted by tens of millions, averages from 300 to 400 to the square mile, and others in which a population, to be counted by some millions, rises to 800, and even 900, to the square mile. These latter probably constitute the most densely-populated districts of the world, the population of the most densely-peopled country of Europe—namely, Belgium—averaging 480 to the square mile. The total population of India is estimated at 250,000,000. Under the old-time system of native rulers, frequent wars, consequent on foreign invasions and internal race antagonisms, with accompanying famines and epidemic diseases, materially restricted the growth of population. But under the conditions of peace, with protection for life and property, which have been attendant in late years on British rule, the population of India is increasing so rapidly—nearly one per cent per annum—and so disproportionately to the amount of new and fertile soil that can be appropriated, as to leave but little margin, under existing methods of cultivation, for increasing the means of subsistence for the people. Much new soil has been put under cultivation during the last century of British rule, and a quarter of a million of square miles of cultivable waste yet remains to be occupied ; but the fact that the national revenues from the taxation of land have not increased to any extent in recent years is regarded as proof that land cultivation is not increasing in proportion to the growth of population, and that the limits of agricultural production are approaching exhaustion. An annual increase of one per cent on the present population of India means at least 20,000,000 more people to feed in ten years, and upward of 40,000,000 in twenty years ; and the problem to which the British Government in India has now before it, and to which it is devoting itself with great energy and intelligence, is, in what way, and by what means, can the character and habits of the people—especially in respect to their methods of agriculture—be so developed and changed that "their industry can become more efficient on practically the same soil ?" Much has been already done in the way of increasing and cheapening, through roads, canals, and railroads, the means of transportation, and in promoting irrigation and education, and especially the use of new tools and methods for cultivating the soil. But so many are the obstacles, and so great is the moral inertia of the people, that, although remarkable progress has been made, the prospect seems to be that, "from decade to decade, larger and larger masses of the semi-pauperized, or wholly pauperized, will grow up in India, requiring state intervention to feed them, and threatening social and financial difficulties of the most dangerous character."

by 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 have received about one fifth of the product. The six great corn States are Illinois, Indiana, Missouri, Iowa, Ohio, and Kansas. They produce more than one half the corn raised in the country. These States, by the census of 1880, had 2,056,770 persons engaged in agriculture, and it would have been necessary for this entire community to have sat astride of shovels and frying-pans for one hundred and ten days out of three hundred and sixty-five to have shelled their corn-crop for the year 1880 by the old processes.

In 1790, before the grain-"cradle" was invented, an able-bodied farm-laborer in Great Britain could with a sickle reap only about a quarter of an acre of wheat in a day; at the present time a man with two horses can cut, rake, and bind in a day the wheat-product of twenty acres.

Forty years ago a deficient harvest in any one of the countries of Europe entailed a vast amount of suffering and starvation on their population. To-day the deficiency of any local crop of wheat is comparatively of little consequence, for the prices of cereals in every country readily accessible by railroad and steamships is now regulated, not by any local conditions, but by the combined production and consumption of the world; and the day of famines for the people of all such countries has passed forever.* The extent to which all local advantages in respect to the supply and prices of food have been equalized in recent years through the railway service of the United States, is demonstrated by the fact that a full year's supply of meat and bread for an adult person can now be moved from the points of their most abundant and cheapest production, a thousand miles, for a cost not in excess of the single day's wages of an average American mechanic or artisan.

The same conditions that one hundred, or even fifty, years ago

* It is not a little difficult to realize that the causes which were operative to occasion famines a hundred years ago in Western Europe, and which have now apparently passed away forever, are still operative over large portions of the Eastern world. The details of the last great famine in China, which occurred a few years ago, indicate that over five million people died of starvation in the famine district, while in other portions of the Empire the crops were more abundant than usual. The trouble was that there were no means of transporting the food to where it was needed. The distance of the famine area to the port of Tientsin, a point to which food could be and was readily transported by water, was not over 200 miles; and yet when the foreign residents of Shanghai sent through the missionaries an important contribution of relief, it required fifteen days, with the employment of all the men, beasts, and vehicles that could be procured, to effect the transportation of the contribution in question over this comparatively short distance. Relief to any appreciable extent to the starving people from the outside and prosperous districts was, therefore, impracticable. Contrast these experiences with the statement that when Chicago burned up in 1871 a train loaded with relief contributions from the city of New York, over the Erie Railroad, reached its destination in twenty-one hours after the time of its departure.

limited the supply of food, and made it confessedly inadequate to meet the demands of a population increasing in a greatly disproportionate ratio, also limited the opportunities for employment to such increasing numbers apart from agriculture. Nearly and probably full one half of all those who now earn their living in industrial pursuits, do so in occupations that not only had no existence, but which had not even been conceived of a hundred years ago. The business of railroad construction, equipment, and operation, which now furnishes employment, directly or indirectly, to about one tenth of all the population of the United States engaged in gainful occupations, was wholly unknown in 1830. Apart from domestic or farm service little opportunity existed for women to earn a livelihood by labor at the commencement of the present century.

The existence of the present populations of Europe and the United States—nay, more, the continuance and progress of civilization itself—has therefore been made possible solely through the invention and use of the same labor-saving machinery, which not a few are inclined to regard as likely to work permanent injury to the masses in the future. It is still easy to avoid all trouble arising out of the use of labor-saving machinery by going to the numerous countries—many of which are rich in the bounties of Nature—which do not possess it. But these are the very countries to which no person of average intelligence desires to go.

Restless and progressive humanity generally believes also, that the continued betterment of the race is largely conditioned on the extension of free government based on popular representation and constitutional safeguards; and also on the successful continuation of the experiment under such conditions which was entered upon by the people of the United States just a hundred years ago. But the Government of the United States, under its existing Constitution, has been made possible only through the progress which man has made in recent years in his knowledge and control of the forces of Nature. Without the perfected railroad and telegraph systems the war for the maintenance of the Federal Union under the existing Constitution could not probably have been prosecuted to a successful conclusion; and even if no domestic strife had intervened, it is more than doubtful whether a federation of numerous States, sovereign in many particulars—floating down the stream of time like an elongated series of separate rafts, linked together—could have been indefinitely perpetuated, when the time necessary to overcome the distance between its extremities for the mere transmission of intelligence amounted to from twenty to thirty days.*

In every highly-civilized country, where accurate investigations have been instituted, the consumption of all the substantial articles of

* When the battle of New Orleans was fought in 1815, more than twenty-two days elapsed before the Government at Washington received any information of its occurrence.

food has, within recent years, been largely and progressively increasing; and as the consumption of rich and well-to-do people in such countries remains almost stationary, inasmuch as they have always been able to have all they desired of such articles, it is reasonable to infer that this result has been mainly due to the annually increasing ability of the masses to consume. In Great Britain, where this matter has been more thoroughly investigated than in any other country, the facts revealed (as will be presently shown) are most extraordinary. In the case of the population of Paris, M. Leroy-Beaulieu also reports a wonderful increase in the consumption of food-products since 1866, and states that, if the ravages of the phylloxera (vine pest) could be checked, and the price of wine reduced, the cost of living for the whole of France would be less than it has ever been during the last half-century.

Furthermore, not only has the supply of food increased, but the variety of food available to the masses has become greater. Nearly all tropical fruits that will bear transportation have become as cheap in non-tropical countries as the domestic fruits of the latter, and even cheaper; and the increased consumption thus induced has built up new and extensive branches of business, and brought prosperity to the people of many localities that heretofore have had no markets for any products of their industry.

An acre of the sea, cultivated by comparatively recently-discovered methods, is said to be capable of yielding as much food as any acre of fertile dry land; but thirty or forty years ago, fish in its most acceptable form—namely, fresh—was only available to consumers living in close proximity to the ocean. Now, fish caught on the waters of the North Pacific, and transported more than 2,000 miles, are daily supplied fresh to the markets of the Atlantic slope of the United States, and sea-products of the coast of the latter, transported 2,000 miles, are regularly furnished in a fresh condition to British markets.

One point of immense and novel importance in helping to a conclusion as to whether the race under the conditions of high civilization is tending toward increased comfort and prosperity, or toward greater poverty and degradation, is to be found in the fact which recent investigators have determined, namely: that in the United States the daily wages paid, or the daily earning capacity of a healthy adult worker, in even the most poorly remunerated employments, is more than sufficient, if properly expended, to far remove the individual recipient from anything like absolute want, suffering, or starvation. Thus, in the case of fifty-nine adult female operatives in a well-managed cotton-mill in Maryland, the per-capita cost of subsistence, with a bill of fare embracing meats, all ordinary groceries and vegetables, milk, eggs, butter, fish, and fruit, has been found to be not in excess of twenty cents per day, including the cost of the preparation of the food and its serving. In Massachusetts, where the results were derived from the six months' boarding of seventeen men and eight women (three servants), the men being engaged in arduous mechanical employments, and consuming comparatively large quantities of meat, the daily cost of the subsistance of each individual was twenty-eight cents per day. In the jails of Massachusetts the average daily cost of the food of the prisoners and of the employés of the prisons for the year 1883—bread of the best quality, good meats, vegetables, tea, rye-coffee, sugar, etc., being furnished liberally—was a trifle over fifteen cents per day for each person.*

In one of the best conducted almshouses of Connecticut, the condition of which has been carefully investigated by the writer, the sum of $7,000 per annum, exclusive of interest on the plant and extraordinary repairs, is believed to be amply sufficient to maintain an average of sixty-five inmates, mainly adults, in a building of modern construction, scrupulously clean, thoroughly warmed and ventilated, with an abundance of good and varied food, clothing and medical attendance, or at an average daily expenditure of about thirty cents per capita.

The evidence, therefore, is conclusive, "that an ample and varied supply of attractive and nutritious food can be furnished in the eastern portions of the United States—and probably in Great Britain also—at a cost not exceeding twenty cents per day, and for a less sum in the western sections of the country, provided that it is judiciously purchased and economically served"; and the legitimate inference from these results is, that the problem of greatest importance to be solved in the United States and in Great Britain, in the work of ameliorating the condition of the honest and industrious poor is (as Mr. Atkinson has expressed it), to find out how to furnish them with ample and excellent food as cheaply as it is supplied to the inmates of our prisons and almshouses.†

The facts in regard to the general increase in the deposits of sav-

* These results are due to the laborious and careful investigations of Mr. Edward Atkinson, of Massachusetts, and were first published in 1884, under the title of "The Distribution of Products." Together with the results of similar investigations conducted by Mr. Robert Giffen, of England, they rank among the most important and valuable contributions ever made to economic and social science.

† The following results of one of the first and most recent efforts to practically carry out this idea are especially worthy of recording in connection with this discussion, and in the highest degree encouraging: Early in the fall of 1887 a number of public-spirited, philanthropic ladies in the city of New York, in charge of a large working-girl's club, determined to try the experiment of founding and managing a working-girl's boarding-house, with a view of ascertaining at what cost a good and varied subsistence and good lodging could be furnished to young women dependent upon their own exertions in a great city for a livelihood, and to whom, by reason of comparatively small incomes, the practice of rigid economy was imperative. For this purpose an attractive and suitable house on a good street was taken at an annual rent of $1,000, and a matron engaged who was thoroughly conversant with the art of advantageously buying and preparing and serving food. As was to be expected, some little time was required to put the experiment

ings-banks, and the decrease in pauperism are also entitled to the highest consideration in this discussion. In the United States the aggregate savings-bank deposits increased from $849,581,000 in 1873, to $2,152,932,000 in 1886, an increase of over 150 per cent in thirteen years, while the increase in the population of the country during that same time was probably not in excess of 30 per cent. The increase in the deposits of the savings-banks of all other countries, for which data are accessible, show the same law of rapid increase, though not in so large a progressive ratio as in the United States. Thus, in Great Britain the increase between 1875 and 1885 as regards deposits was 40 per cent, and in the number of depositors over 50 per cent,* while the increase in population during the same period was about 10 per cent. Switzerland and Sweden and Norway lead all the nations of Europe in the ratio of savings-deposits to the population—the increase, comparing 1860 with 1881, having been from the ratio of 4·2 to 35·5 in the former, and in the case of the latter, from 6·8 to 18·1. In Prussia, where the savings-banks are used almost exclusively by the poorer classes, the deposits for 1886 showed an increase of 876,000,000 marks over the year 1878. The percentage increase in deposits and depositors in France and Italy in recent years has also been large, and far in excess of any percentage increase in their population. The aggregate savings-deposits in various institutions and societies for the Continent of Europe, in 1885, was estimated at £338,000,000; or, including Great Britain, £538,000,000 ($2,690,000,000).

There are no statistics of national pauperism in the United States, and general conclusions are based mainly on the returns made in the eight States of New York, Pennsylvania, Ohio, Illinois, Massachusetts, Wisconsin, and Michigan. A report made by the standing com-

in full operation, and therefore the full details of the results of but one month (November, 1887), can be here furnished.

For this month the family consisted of twenty-one adult persons (females), including matron and servants; and the entire disbursements for all running expenses, except for fuel and rent, were $236.41, which were itemized as follows: food, $151.19; gas and oil, $8.83; ice, $1.30; incidentals, $9.54; furnishing, $9.05; salary of matron, $20.00; wages, $36.50. The average expense per individual per week was $2.81⅝. The average expenditure for food for each individual per week was $1.74; per day 24 cents. The sum of $276.30 was received for board, leaving a balance applicable for fuel and rent, for the month, of $49.71. The persons composing the family were not factory-hands, but stenographers, milliners, type-writers, and a few art students. The food furnished was not what would be properly called "cheap," but every way excellent; and the table is believed to far excel what will ordinarily command a charge of from $8 to $10 per week. As might be inferred, the larger rooms of the house were required to accommodate more than one person, but there was no crowding.

* The amount of deposits in the British Savings-Bank for 1886 was £98,000,000 ($490,000,000). But besides the savings-banks, there are in Great Britain a number of institutions for the promotion of thrift, which have no exact counterpart in the United States, and which hold also large amounts of the savings of the people, as railway savings-banks, incorporated provident building societies (with £50,000,000 of funds in 1885), friendly societies, etc., and in all of which the deposits are rapidly increasing.

mittee of the various State boards of charities to the National Conference of Charities in 1887 was, that "except for the insane, who are everywhere constantly accumulating beyond their due ratio to the whole population, there has never been for a period of five years any increase in the proportion of paupers to the population; while for longer periods there has generally been a decrease in the number of the poor as compared with the whole population"; and this, too, notwithstanding the very great obstacles which stand in the way of all public and private effort for the checking of pauperism in a country like the United States, "which annually receives such armies of poor from European countries, and at home permits intemperance to breed so much of pauperism, especially in cities."

In England, where the population, between 1875 and 1885, increased in a larger proportion than in any previous decade, there was no increase, but a very steady decrease of pauperism; or, from an annual average number of 952,000, or 4·2 per cent of the whole population in 1870–'77, to 787,000, or 3 per cent of the population for 1880–'84. For Scotland, the corresponding figures are much the same; although the Scotch administration of the poor is totally independent of that of the English. In short, there is no evidence that pauperism is increasing in England and Scotland with their recent marked increase in population, or that the people are less fully employed than formerly; but the evidence is all to the contrary. In Ireland, the experience has been different. "Here, there has been an increase in pauperism, accompanied by a decline in population," the number of paupers in receipt of relief, on the 1st of January, 1887, being returned as 113,241, as compared with 106,717 in 1883.* Comparing 1880 with 1850 the decline of pauperism in the United Kingdom was about 40 per cent.

Prussia, with a marked increase in population, returned a decrease in the number of paupers receiving relief from cities and towns from 3·87 per cent of the whole number in 1884, to 3·65 per cent in 1885.

Crime in Great Britain is diminishing. The same is reported of Italy. In the United States, while crime has diminished in a few States, for the whole country it has, within recent years, greatly increased. This is to be attributed, in the Northern States, mainly to the great foreign immigration, and, in the Southern, to the emancipation of the negroes.

Finally, an absolute demonstration that the progress of mankind, in countries where the new economic conditions have been most influential in producing those disturbances and transitions in industry and society which to many seem fraught with disaster, has been for the better and not for the worse, is to be found in the marked prolongation of human life, or decline in the average death-rate, which

* "The Material Progress of Great Britain"; address before the Economic Section of the British Association, 1887, by Robert Giffen.

has occurred within comparatively recent years in these same countries. Thus, the average annual death-rate in England and Wales, during the period from 1838 to 1875, was 22·3 per thousand. From 1876 to 1880, it was 20·8. But, for the six years from 1880 to 1887, the average has not exceeded 19·3 ; which means that about 500,000 persons in England and Wales were alive at the close of the year 1886 who would have been dead if the rate of mortality which prevailed between 1838 and 1875 had been maintained.* The average death-rate for the whole United States, for the census-year 1880, was between 17 and 18 per 1,000 ; which is believed to be a less mean rate than that of any European country except Sweden.

The results of the most recent and elaborate investigations on this subject, communicated, with data, by M. Vachee, to the "Bulletin de l'Institute International de Statistique," Rome, 1887, are, that the mortality of Europe has diminished from 25 to 33 per cent, and that the mean duration of life has increased from seven to twelve years, since the beginning of this century. This estimate of the rate of improvement for all Europe is higher than the English data would alone warrant, but may be correct. At the same time it is well recognized, that through the absence of reliable data it is impossible to speak *with certainty* as to the decrease in mortality, or as to the expectation of life in any country, except in respect to the last forty or fifty years.

Now, while improved sanitary knowledge and regulations have contributed to this result, it has been mainly due to the increase in the abundance and cheapness of food products ; which in turn are almost wholly attributable to recent improvements in the methods of production and distribution. But whatever may have been the causes of these changes, they could not have occurred without an increase of vitality among the masses.

Again, if civilization is responsible for many new diseases, civilization should be credited with having stamped out, or greatly mitigated not a few that a century ago were extremely formidable. Plague and leprosy have practically long disappeared from countries of high civilization. For the five years from 1795 to 1800 the average annual number of deaths from small-pox in the city of London was 10,180 ; but for the five years from 1875 to 1880 it was only 1,408. Typhus and typhoid fevers are now known to be capable of prevention, and cholera and yellow fever of complete territorial restriction. Typhus fever, once the scourge of London, and especially of its prisons, is said to have now entirely disappeared from that city. No living physician has seen malignant syphilis as described in 1786 by the eminent English surgeon, John Hunter. Anæsthetics have removed the pain attendant upon surgical operations ; and the use of antiseptics has re-

* It is also to be noted that by far the larger proportion of the increased duration of human life in England is lived at useful ages, and not at the dependent ages of either childhood or old age.

duced the mortality contingent upon the same in the larger hospitals; or, taking the experience of Germany as the basis of comparison, from 41·6 in 1868, to 4·35 per cent in 1880.

Dealers in ready-made clothing in the United States assert that they have been obliged to adopt a larger scale of sizes, in width as well as in length, to meet the demands of the average American man, than were required ten years ago; and that in the case of clothing manufactured for the special supply of the whole population of the southern sections of the country, this increase in size since the war, attributable almost entirely to the increased physical activity of the average individual, has been fully one inch around the chest and waist. Varieties of coarse clothing, as the brogan shoe and cotton drills, which before the war were sold in immense quantities in this same section of the country, have now almost passed out of demand, and been superseded by better and more expensive products. The American is, therefore, apparently gaining in size and weight, which could not have happened had there been anything like retrogression, or progress toward poverty on the part of the masses.

But the contribution of greatest value that could be made to the discussion of this subject, would be to spread before us an exhibit of the exact results of the experience of a country and a people, where under average, or not too favorable conditions, the recent changes in industrial and social life, consequent upon the new methods of production and distribution, have operated most influentially. Such an exact exhibit can not be made; but the experience of Great Britain, where economic data have been gathered and recorded during the last fifty years with an exactness and completeness not approached in any other country, furnishes a most gratifying and instructive approximation. To the record of this experience, attention is next requested.

During the last twenty-five or thirty years, the aggregate wealth of Great Britain, as also that of the United States and France, has increased in an extraordinary degree. In Great Britain the increase from 1843 to 1885 in the amount of property assessable to the income-tax is believed to have been 140 per cent, and from 1855 to 1885 about 100 per cent. The estimate of the total income of the country for 1886 was £1,270,000,000; and of its aggregate wealth, about £9,000,000,000, or $45,000,000,000. Have now the working-classes of Great Britain gained in proportion with others in this enormous development of material wealth? Thanks to the labors of such men as the late Dudley Baxter, Leon Levi, David Chadwick, and Robert Giffen, this question can be answered (comparatively speaking for the first time) with undoubted accuracy.

Fifty years ago, one third of the working masses of the United Kingdom were agricultural laborers; at present less than one eighth of the whole number are so employed. Fifty years ago the artisans represented about one third of the whole population; to-day they represent three fourths. This change in the composition of the masses of itself implies improvement, even if there had been no increase in the wages of the different classes. But, during this same period, the "money" wages of all classes of labor in Great Britain have advanced about 100 per cent, while the purchasing power of the wages in respect to most commodities, especially in recent years, has been also very great. Among the few things that have not declined, house-rent is the most notable, a fact noticed equally in Great Britain and France, although in both countries the increase in the number of inhabited houses is very large; the increase in the item of houses in the income-tax assessments of the United Kingdom between 1875 and 1885 having been about 36 per cent.* But high rents, in the face of considerable building, are in themselves proof that other things are cheap, and that the competition for comfortable dwellings is great.

The Government of Great Britain keeps and publishes an annual record of the quantities of the principal articles imported, or subject to an excise (internal revenue) tax, which are retained for home consumption per head, by the total population of the kingdom. From these records the following table has been compiled. From a humanitarian point of view, it is one of the most wonderful things in the history of the latter half of the nineteenth century:

Per-capita consumption of different commodities (imported or subject to excise taxes) by the population of Great Britain.

ARTICLES.	1840.	1886.	ARTICLES.	1840.	1886.
Bacon and hams . . Lbs.	0·01	11·95	Raw sugar . . . . Lbs.	15·20	47·21
Butter . . . . "	1·05	7·17	Refined sugar . . . . . "	None.	18·75
Cheese . . . . "	0·92	5·14	Tea . . . . "	1·22	4·87
Currants and raisins "	1·45	4·02	Tobacco . . . . "	0·86	1·42
Eggs . . . . No.	3·63	28·12	Wine . . . . Gals.	0·25	0·36
Rice . . . . Lbs.	0·90	10·75	Spirits (foreign) . . "	0·14	0·24
Cocoa . . . . "	0·08	0·41	Spirits (British) . . "	0·83	0·73
Coffee . . . . "	1·08	0·86	Malt . . . . Bush.	1·59	1·64*
Wheat and wheat flour, Lbs	42·47	185·76	Beer (1881) . . . . . . Gals.	27·78	26·61

* 1879.

During all the period of years covered by the statistics of this table, the purchasing power of the British people in respect to the necessities and luxuries of life has therefore been progressively increasing, and has been especially rapid since 1873–'76. Converting this increase in the purchasing power of wages into terms of money, the British workman can now purchase an amount of the necessaries of life for 28*s.* 5*d.*, which in 1839 would have cost him 34*s.* 0½*d.*† But this statement falls very far short of the advantages that have accrued

* The value of the new houses built in Great Britain since 1840 has been estimated at double the value of the British national debt.

† David Chadwick. British Association, 1887.

to him; for wages in Great Britain, as before stated, are fully 100 per cent higher at the present time than they were in 1839.

The impression probably prevails very generally in all countries that the capitalist classes are continually getting richer and richer, while the masses remain poor, or become poorer. But in Great Britian, where alone of all countries the material (i. e., through long-continued and systematized returns of incomes and estates [probate] for taxation) exists for scientific inquiry, the results of investigation demonstrate that this is not the case.

In the case of estates, the number subjected to legacy and succession duties within the last fifty years has increased in a ratio double that of population, but the average amount of property per estate has not sensibly augmented. If, therefore, wealth among the capitalist classes has greatly increased, as it has, there are more owners of it than ever before; or, in other words, wealth, to a certain extent, is more diffused than it was. Of the whole number of estates that were assessed for probate duty in Great Britain in 1886, 77·5 per cent were for estates representing property under £1,000 ($5,000).

In the matter of national income, a study of its increase and apportionment among the different classes in Great Britain has led to the following conclusions: Since 1843, when the income-tax figures begin, the increase in taxable income is believed to have been £755,000,000. Of this amount, the *income* from the capitalist classes increased about 100 per cent, or from £190,000,000 to £400,000,000. But, at the same time, the number of the capitalist classes increased so largely that the average amount of capital possessed among them per head increased only 15 per cent, although the increase in capital itself was in excess of 150 per cent. In the case of the "upper" and "middle" classes, the income from their "working" increased from £154,000,000 to £320,000,000, or about 100 per cent; while, in the case of the masses (i. e., the manual-labor classes), which have increased in population only 30 per cent since 1843, the increase of their incomes has gone up from £171,000,000 to £550,000,000, or over 200 per cent. Between 1877 and 1886 the number of assessments in Great Britain for incomes between £150 ($750) and £1,000 ($5,000) increased 19·26 per cent, while the number of assessments for incomes of £1,000 and upward decreased 2·4 per cent.* What has happened to all that large class

* The following table shows how wealth is distributed in the different classes of income-tax payers in Great Britain under Schedule D, which comprises incomes from profits on trades and employments:

"In 1877 the number of assessments of incomes from £150 to £500 was 285,754, and in 1886 it was 347,031, showing an increase of 21·4 per cent; of incomes between £500 and £1,000, the numbers were, in 1877, 32,085, and in 1886, 32,033, no increase at all; of incomes between £1,000 and £5,000, the numbers were, in 1877, 19,726, and in 1886, 19,250, a decrease of 2·4 per cent; and of the incomes over £5,000, the numbers were, in 1877, 3,122, and in 1886, 3,048, a decrease of 2·3 per cent. It results that from these figures the increase of the income-tax during times of depression and during ordinary whose annual income does not reach the taxable limit (£150) is sufficiently indicated by the fact that while population increases pauperism diminishes.

Thus, in the United Kingdom, during the last fifty years, the general result of all industrial and societary movement, according to Mr. Giffen, has been that "the rich have become more numerous, but not richer individually; the 'poor' are, to some smaller extent, fewer; and those who remain 'poor' are, individually, twice as well off on the average as they were fifty years ago. The poor have thus had almost all the benefit of the great material advance of the last fifty years."

The following further citations from the record of the recent economic experiences of Great Britain are also strongly confirmatory of the above conclusions:

The amount of life insurance in the United Kingdom exceeds that of any other country; and the record here is a very rapid increase in the number of policies issued, but a large decrease in the average amount of the policies; the meaning of which clearly is that a larger number of people are not only continually becoming provident, but able to insure themselves for small amounts.

The changes in the relations of crime and of educational facilities during the last fifty years of the history of the British people, which have occurred and are still in progress, are in the highest degree encouraging. In 1839 the number of criminal offenders committed for trial was 54,000; in England, alone, 24,000. Now the corresponding figures (1886) were, United Kingdom, 19,446; England, 13,974. In 1840 one person for every 500 of the population of the British Islands was a convict; in 1885 the proportion was as one to every 4,100.

As late as 1842 there was no national school system in England, and there were towns with populations in excess of 100,000 in which there was not a single public day-school and not a single medical charity. In 1886 the number of attendants upon schools in the United Kingdom was reported at 5,250,000. In the same year the number in attendance upon schools, for the support of which grants of money are made by Parliament (and which correspond to the public schools of the United States) was 3,915,315, an increase over the preceding year of 85,335. The amount of such Parliamentary grants for 1886 was £3,945,576 ($19,728,830).

The change which has taken place in the relations of the Government of Great Britain to the national life of its people is also very remarkable. Thus at the commencement of the present century the British Government annually appropriated and spent about one third

times, during the times which we have been going through and which have not been times of great prosperity, there has been a most satisfactory increase in the incomes below £500, while no similar increase is seen in the incomes between £500 and £1,000, and upward."—Mr. Goschen, "*On the Distribution of Wealth*," *Royal Statistical Society of England, 1887.*

of the national income; now it expends annually about one twelfth. But for this greatly diminished expenditure the masses of the people now receive an immensely greater return than ever before; in the shape of increased postal and educational facilities, safer navigation, greater expenditures for the maintenance of the public health and public security, greater effort for preventing abuses of labor, etc.

The general conclusion from all these facts, as Mr. Giffen has expressed it, is that what "has happened to the working-classes in Great Britain during the last fifty years, is not so much what may properly be called an improvement, as a revolution of the most remarkable description." And this progress for the better has not been restricted to Great Britain, but has been simultaneously participated in to a greater or less extent by most, if not all, other countries claiming to be civilized. So far as similar investigations have been instituted in the United States, the results are even more favorable than in Great Britain. If they have not been equally favorable in other than these two countries, we have a right to infer that it has been, because the people of the former have not only started in their career of progress from a lower level of civilization and race basis than the latter, but have had more of disadvantages—natural and artificial—than the people of either Great Britain or the United States. The average earnings per head of the people of countries founded by the Anglo-Saxon race are confessedly larger than those of all other countries.*

But some may say; this is all very interesting and not to be disputed. But how does it help us to understand better and solve the industrial and social problems of to-day, when the cry of discontent on the part of the masses is certainly louder, and the inequality of condition, want, and suffering is *claimed* to be greater than ever before? In this way.

The record of progress in Great Britain above described is indisputably a record that has been made under circumstances that, if not wholly discouraging, were certainly unfavorable. It is the record of a country densely populated and of limited area, with the ownership, or free use of land, restricted to the comparatively few; with (until recent years) the largest national debt known in history; with a heavy burden of taxation apportioned on consumption rather than on accumulated property, and the reduction of which, a participation in constant wars and enormous military and naval expenditures has always obstructed or prevented; with a burden of pauperism at the outset, and, indeed, for the first half of the period under con-

* A recent British authority (Sir Richard Temple) makes the highest average earnings per head in any country at the present time to be in Australia, namely, £41 4*s*. Next in order, he places the United Kingdom, with an average per-capita earning capacity of £35 4*s*.; then the United States, with an average capacity of £27 4*s*.; and next, Canada, with an average of £26 18*s*. For the Continent of Europe the average is estimated at £18 1*s*.

sideration, which almost threatened the whole fabric of society ; and, finally, with a long-continued indisposition on the part of the governing classes to make any concessions looking to the betterment of the masses, except under the pressure of influences which they had little or no share in creating. And yet, without any "violent specifics," or radical societary changes, and apart from any force of statute law, except so far as statute law has been an instrumentality for making previously-existing changes in public sentiment effective ; but rather through the steady working of economic laws under continually increasing industrial and commercial freedom, the working masses of Great Britain, "in place of being a dependent class, without future and without hope, have come into a position from which they may reasonably expect to advance to any degree of comfort and civilization."

Now, with humanity occupying a higher vantage ground in every respect than ever before ; with a remarkable increase in recent years in its knowledge and control of the forces of Nature—the direct and constant outcome of which is to increase the abundance of all useful and desirable commodities in a greater degree than the world has ever before experienced, and to mitigate the asperities and diminish the hours of toil—is it reasonable to expect that further progress in this direction is to be arrested? Is the present generation to be less successful in solving the difficult social problems that confront it than were a former generation in solving like problems which for their time were more difficult and embarrassing? If the answer is in the negative, then there is certainly small basis for pessimistic views respecting the effect of the recent industrial and social transitions in the future.

But, in view of these conclusions, what are the reasons for the almost universal discontent of labor?

THE MOON AND THE WEATHER.

By JOHN WESTWOOD OLIVER.

THE persistent survival of weather-lore in these days of intellectual emancipation is not at all remarkable when we consider the extent to which the vulgar sayings embody real truths. A few years ago Messrs. Abercromby and Marriott embarked on an extremely interesting inquiry with a view to determine, by actual comparison, how far the popular proverbs express relations, or sequences, which the results of meteorological science show to be real. The investigation proved that something like a hundred of the more popular sayings are, under ordinary conditions, trustworthy. Such being the case, we need not be surprised that simple country folk prefer familiar couplets to all the "isobars," "cyclones," and "synchronous charts," in the world.

If "hills clear, rain near," means the same as "the presence of a wedge-shaped area of high pressure, accompanied by great atmospheric visibility, is likely to be followed by the advance of a disturbance with rain and southerly winds," which for all practical purposes it does, the preference is justified on the mere ground of breath economy. The thirty-one words demanded by science stand no chance against four.

But it is unfortunate that, along with the limited number of folk-sayings founded on truth, there has survived a very large number founded on the grossest error. These latter have borrowed credence and respect from the proved credibility of the others, and apparently they are all destined to sink or swim together. Hammer as we will at certain favorite proverbs which we know to be based upon error, it is all in vain. The reverence for tradition is too much for us. And of all the superstitions, pure and simple, which defy our attempts at destruction, the most invulnerable are those ascribing certain effects to the influence of the moon. Few of the counties in England, Scotland, and Ireland but have their own peculiar observances referring to the supposed lunar influence upon diseases, destiny, etc. To merely enumerate these would require a small volume. Any who may care to see some specimens should consult a curious collection (but far from an exhaustive one) published last year by the Rev. Timothy Harley, under the title "Moon Lore." And of equal vitality with the other moon-myths is the idea of lunar influence upon the weather. There is this important difference, however, that while the attribution of supernatural powers to the moon is palpably and admittedly absurd, the idea of her influence on the weather is not founded on anything physically impossible, and has the sanction of striking analogy in the accepted doctrine of the tides. How much importance was attached to the inquiry, regarded as a true scientific investigation, in the earlier half of the century, and up even to very recent years, may be seen by consulting a meteorological bibliography. The constant succession of papers in English, French, and German, by accredited scientific men, and contributed to respectable scientific societies and periodicals, dealing with the lunar weather theory in all its aspects, shows this to have been long considered one of the most important problems of meteorology.

The doctrine of the survival of the fittest would not seem to be applicable to the case of wise saws. The criterion of fitness we may take to be the reliableness of the saw, and, as we have just seen, they survive without the slightest reference to that characteristic. Nevertheless, one is loath to believe that formulated nonsense can have found credence for ages unless there is a larger admixture of truth in it than is readily apparent by the light of our present knowledge. Popular error has been described as the perception of half the truth, or of one side of a truth. Were this invariably so, it would afford a profitable employment to dissect popular errors with a view to discovering the half-truth, since we might be able to find its complement somewhere, and materially enrich the world. But that is not the sense I intend to convey. Nearly all weather sayings are of the nature of predictions. They describe a certain appearance of phenomenon, and then go on to say what other appearance or phenomenon may be expected to follow it. We have here a sequence of events; the ground of the saying (if it has any ground at all) is the invariability of the sequence. Now it is difficult to imagine such sequences being invented without any reference to the observed fact, and it is still more difficult to imagine them obtaining currency—not local currency merely, but sometimes universal currency—unless a certain number of observed instances have borne them out. Of course, by the laws of chances any sequence within the range of probability is bound to happen sometimes, but a sequence of weather phenomena is liable to variation in so many different directions that the purely chance happenings of any specified sequence are not numerous relatively to the blanks. I am disposed to assume, therefore, that all weather proverbs of this nature are founded upon one observed instance; and that, although many are only based upon the accidental recurrence of the sequence (and are consequently worthless), many also are the expression of a real, demonstrable sequence of sufficiently frequent occurrence to afford ground for the rough approximation which suffices to constitute a popular weather law.

But it does not follow that because we assume the fact of an apparent connection between two phenomena, and predict from the manifestation of the one the approaching manifestation of the other, the connection must necessarily be of the nature of cause and effect, nor yet of the nature of successive effects of the same cause. There is such a thing as the coincidence of phenomena. The coincidence may be purely fortuitous, or it may be the result of the operation of higher laws of which we as yet have no knowledge.

We may now proceed to the more immediate subject of this article. It is not my intention to attempt to give an exhaustive collection of lunar proverbs. Such collections are curious, but they are not particularly useful. Nor do I aspire to propound any new theory of lunar influence on the weather. What I do propose is to discuss a few of the best known, and therefore most important, of the popular weather notions in which the moon is concerned, with the view of showing the necessity for discrimination in their acceptance; the ultra-scientific man who pooh-poohs everything that has moon in it being really as wide of the mark as the poor victim of superstition who puts double faith in things on the same ground. In arranging my remarks it will be convenient to deal successively with (1) lunar notions that are utterly absurd; and (2) those that are explicable by the aid of physical principles, and are therefore rational and useful in practice.

To the former class belongs the idea, in its various forms, of a direct lunar influence; and I would begin with that most ubiquitous—and apparently everlasting as well—of all popular absurdities, the table known as "Herschel's Weather Table." How it ever came to be associated with the name of the greatest of English astronomers is a mystery. I once put the question in "Notes and Queries," where the obscurest of literary enigmas are often solved, but to no purpose. Whatever the explanation may be, the table is certainly weighted with Herschel's great authority, and to this day we find it in nearly all the almanacs, and even in some less ephemeral publications, gravely quoted as the embodiment of scientific truth. It is not necessary to take up space with the whole table, as it is only too well known, and can be seen in almost any almanac. It states that if the moon changes, or becomes full, or enters her first or third quarter between noon and two in the afternoon, the "resulting weather" (that is, I presume, the weather during the ensuing week, or until a new change inaugurates a new state of things) will be, in summer, "very rainy," and in winter "snow and rain." If the change of moon takes place between two and four in the afternoon, the resulting weather will be "changeable" in summer (a pretty safe prediction in this climate), and "fair and mild" in winter. And so on for the whole twenty-four hours. Now, it will be observed that the lunar influence assumed here is of an occult nature. There is no pretense of physical agency in the matter. The weather will be such and such, not because the moon's reflection of light is greater or smaller, nor because her radiation of heat is more or less, nor because her position with respect to the earth is nearer or farther away, but simply because she "changes" between certain arbitrary hours. What virtue there can be in the moon's "change" is hard indeed to see. The principle involved must be an astrological one, for in reality the moon is gradually, if imperceptibly, "changing" during every moment of her increase from new to full, and her decrease from full to new again, the quarters being only stages in the process specially marked for the sake of convenience. There is precisely the same degree of visible difference between a three-days'-old moon and a ten-days'-old one as there is between a new moon and a moon in her first quarter; but in the former case (so we are asked to believe) the difference is impotent to rule the weather because it does not coincide with the conventional "change." To look at the matter in another way, it will be noticed that the table provides for a change occurring at any hour in the twenty-four, and, as the moon can not escape the necessity of changing sometimes, it follows that the weather for the year—and not only for the year, but for as long as the sun, earth, and moon retain their relative position and motions—is reducible to a cut-and-dry order; such an order, no doubt, as the compilers of Zadkiel's, Orion's, and the Belfast Almanacs assume. Need the British public be assured that no such convenient orderliness in our weather phenomena exists? And, finally, the "changes" of the moon are not exclusively confined to England, nor to any one country. The new moon waxes into the full moon simultaneously all the world over. Moreover, the "change" takes place simultaneously all the world over. Consequently, when the change occurs between 12 and 2 P. M., it means that the weather will be "very rainy" in every part of the earth where summer is, while "snow" must prevail wherever the conditions are such as to make rain impossible; and what becomes of those local variations which are the experiences of everybody who has traveled twenty miles upon the terrestrial globe? Predictions founded upon this preposterous weather table are not one whit more worthy of serious attention than those contained in Zadkiel's Almanac; but, while the latter are admittedly addressed only to the grossly ignorant and credulous, the table unfortunately retains its character of respectability unimpaired.

As an example of elaborate nonsense, I know of nothing better than a table "showing the probabilities of a change of weather at or after each of the moon's situations throughout an entire revolution in her orbit," which received the honor of recognition and approval in a cyclopædia of not very ancient date. The table names the moon's ten "situations" (conjunction, opposition, first quarter, third quarter, perigee, apogee, ascending equinox, descending equinox, northern lunistice, and southern lunistice), and opposite each gives the "chances that the weather will change" with the most exquisite exactitude. Thus, there are six chances to one that a change will take place about new moon, but only five to two in favor of a change about the full. At the time of the northern lunistice the chances are eleven to four, at the southern three to one (note the minute difference). Unlike Herschel's table, this one has reference to a lunar "influence" which depends for its intensity, as any physical influence necessarily would do, upon the nearness or distance of its source, and also upon the position of that source relative to the sun, which may be regarded as the seat of an opposing or antagonistic influence. This is all quite rational, and is well calculated to impress the unscientific mind, while the exquisite precision with which the probabilities are stated, greatly enhances the effect. But what is the outcome of it? Taking the ten specified points in each lunation, and calling a lunation, roughly, thirty days, and then averaging the "probabilities," we discover that this table, which looks for all the world as if it might be the condensed result of years of observation and much laborious calculation, merely expresses (or, more properly speaking, conceals) the simple fact, that in every three days there are about three chances to one that the weather will undergo a change!—which, so far as this country is concerned, is only too true.

"If Christmas comes during a waxing moon we shall have a very good year; and the nearer to the new moon the better. But if, during the waning moon, a hard year; and the nearer the end of the moon, so much the worse." This saying is typical of a good many others. The fact that a festival is invariably selected, points to a purely superstitious origin, for we have no physical grounds for supposing a festival-day to determine the weather conditions which are to follow any more than an ordinary day. Unlike the tables we have been discussing, there is not even the semblance of scientific authority here. The chief agent is not physical, but religious. The moon is always either waxing or waning; it is her nature so to do. But that of itself signifies nothing; it is when Christmas happens upon a waxing or waning period that we have the critical combination.

Southey, in one of his letters, writes: "Poor Littledale has this day explained the cause of our late rains, which have prevailed for the last six weeks, by a theory which will probably be as new to you as it is to me. 'I have observed,' he says, 'that when the moon is turned upward, we have fine weather after it; but if it is turned down, then we have a wet season: and the reason, I think, is, that when it is turned down it holds no water, like a basin, you know, and then down it all comes.'" Southey found, upon inquiry, that this was a common notion in the lake district. George Eliot, as Mr. Harley points out, has a reference to the same fancy in "Adam Bede." If Jamieson's "Scottish Dictionary" is to be trusted, the same belief is exactly reversed in Scotland. Jamieson states that it is considered as an almost infallible presage of *bad* weather if the moon "lies sair on her back." Of the two forms of the saying, the English one is infinitely to be preferred, for it embodies rather a pretty idea, while the Scotch one is simply nonsensical. The moon might "lie sair on her back" were it she herself that was "bad," but scarcely on account of an approaching disturbance of the weather. To explain the conditions under which the crescent moon is tilted forward or backward, would require little short of a treatise on the lunar and terrestrial motions, a digression for which we have no space; but it is sufficiently obvious that to attribute an influence to the "attitude" of the visible moon is open to the fatal objection that, like the "change," it is not a sudden but a gradual phenomenon, which ought to exercise its influence through all the stages of its progress, instead of only when a weather-wise person happens to notice it.

One of the most curious, and certainly one of the most widespread, of all weather beliefs is that of the "Saturday moon." The notion is that when the new moon falls on a Saturday it is invariably followed by a period of wet and unsettled weather. The currency of this belief is remarkably wide. Not only is it found (more or less modified) in the folk-lore of England, Scotland, and Ireland, but it is held also by seamen of all nationalities. A traveler relates that he once heard it referred to by a Chinese pilot. And more than this, in 1848, a Dr. Forster announced to the Royal Astronomical Society, as the result of an examination of weather registers kept by his grandfather, his father, and himself, extending over nearly eighty years, that nineteen times out of twenty a new moon on Saturday was followed by twenty days of rain and wind. It is not many weather sayings that enjoy the supporting testimony of a sober scientific investigation, and that circumstance, together with the general acceptance in which the saying is held, entitles it to special consideration.

Could we reduce the occurence of a Saturday moon to any form of periodicity—that is to say, were the accident of the new moon falling on a Saturday to recur at regular intervals—we should have some ground for at least provisionally admitting the truth of the rule, since we know that many weather phenomena are roughly periodical (though the periodicity is often completely masked by the disturbing operation of local influences), and it might so happen that this weather period coincided with that of the Saturday moon. The "cold snaps" in May, for example, recur periodically; and a cause for the phenomenon has been found in the passage of dense meteor flights between the sun and the earth, the meteors intercepting a portion of his heat. But the Saturday moon is not exactly periodical. In 1881 not a single new moon fell on a Saturday. In 1883 there were three conjunctions so distinguished. This year there are two. What sort of weather period can we imagine guilty of such eccentricities? Of course, had the adage referred to a particular Saturday moon it would have been different. The new moon falls on the same day again after a lapse of about nineteen years (a circumstance that gave rise to the Metonic cycle), and the rule would then have meant that a period of wet and windy weather occurred at a certain season every nineteen years—a notion in striking accordance with a favorite cycle of the cycle hunters. No such interpretation is possible, however, and we are obliged to include this much-respected saying in the category of idle superstitions.

We come now to the more edifying class of lunar weather notions —those that have a real physical basis. And it may not be out of place to repeat here that the writers who so emphatically and unreservedly denounce the moon and weather idea a vulgar superstition overstep the limits of scientific truth. So far as any influence of the kind we have been considering is concerned, they are quite right. The moon exerts no influence upon our atmosphere strong enough, by comparison with the other influences at work, to produce a marked correspondence between the lunar and atmospheric phenomena. Of that we are certain. Let us, therefore, belabor the false doctrine upon which the preceding and many similar notions are founded with all our might. But because the moon certainly is not a dominant factor in our weather, it does not follow that we are justified in denying to it an influence of any kind. And the results of sundry investigations have been such as to render it prudent to regard the existence of *some* physical connection between the two as at least an open question. Atmospheric tides, due to the moon's attraction, must exist, unless the whole theory of gravitation be wrong, and in a few cases they have been successfully traced in the barometrical records; but in general they are totally obliterated by the ordinary and very much larger disturbances due to other causes. The heating effect of the moon's rays has been the subject of several careful experiments. Melloni, in 1846, started the investigation, and since then Piazzi Smyth (on Teneriffe) and Lord Rosse (at Parsonstown) have endeavored to make precise determinations, with results that place beyond doubt the fact that moonlight does contain a minute proportion of heat-rays, mostly of the dark sort. More recently, Professor Langley's experiments with the bolometer have confirmed that conclusion. In the face of such results, insignificant though they admittedly are by comparison with the effects popularly attributed to lunar influence, it is not correct to say that science absolutely discountenances the notion of any connection between the moon and the weather. For although a barometrical fluctuation so slight as to defy most efforts to discover it, and a thermometrical effect so infinitesimal as to require a very elaborate as well as delicate apparatus to detect it, can not in any sense be called "weather," it is not unfair to assume—granted the physical influence—that it may work upon the atmosphere in ways to which our instrumental results afford no clew.

We have an example of this in the circumstance which no less careful an observer than Sir John Herschel remarked, "without any knowledge of such a tendency having been observed by others"—the circumstance that the sky is clearer, generally speaking, about the time of full moon than when she is in her quarters. Humboldt mentions this as a fact well known to the pilots and seamen of Spanish America. The explanation has been suggested that clear nights are more *conspicuous* when the moon is full than when the stars alone diffuse their feeble glimmer, and that clearness in the one case is likely to arrest the attention and be remembered more readily than in the other. One might be disposed to accept the explanation did not Herschel plainly state the tendency to disappearance of clouds under the full moon as a meteorological fact; and he was too experienced an observer to be easily misled by an illusion of the memory. Now, both Lord Rosse's experiments with the three-foot mirror, and those of Professor Langley with the bolometer, have proved that the lunar heat-rays are chiefly dark rays; and Tyndall has shown that "dark heat" is very ready to undergo absorption. It may, therefore, be inferred that much of the heat sent to us by the moon—the quantity of which varies with her phase—is absorbed by the aqueous vapor in the higher regions of the atmosphere; and the direct result of this must be to raise the temperature of the air above the clouds, cause increased evaporation from their surface, and so effect, in a certain measure, their dispersion. Again, a necessary consequence of the dispersion of the clouds is increased radiation from the earth's surface, producing a reduction of temperature in the air near the ground ; and Mr. Park Harrison, who discussed a series of temperature observations made at Oxford, Greenwich, and Berlin, found a mean decrease of more than 2° F. about the time of full moon. The French proverb of *la lune rousse*, which Louis XVIII bewildered Laplace by asking him to explain, may be accounted for by the aid of these researches. The name of "red moon" is applied to the moon which is full at the end of April or early in May, because during the clear nights which then prevail, the tender leaves and buds are frozen and turn red ; and popular superstition attributes this effect to the peculiar action of the "red moon's" rays. It is at least curious that the connection assumed in this superstition between the full moon, clear nights, and May frosts should be one that is suggested by independent scientific results.

Apart from any question of lunar influences, however, there are many popular prognostics which make use of the moon merely as a convenient exhibitor of certain atmospheric effects — effects which would not be visible without the moon to show them up, but in the production of which that orb plays no part whatever ; and in so far as sweeping denunciations of lunar weather proverbs include these, discredit is thrown on a class of useful sayings very unjustly.

There is, perhaps, no better known lunar prognostic than that referred to in the old Scotch ballad of Sir Patrick Spens :

"O ever alack! my master dear,
I fear a deadly storm.
I saw the new moon late yestreen,
Wi' the auld moon in her arm;
And if ye gang to sea, maister,
I fear will suffer harm."

Chambers, in "The Book of Days," says that to see "the old moon in the arms of the new one" is reckoned a sign of *fine* weather—another curious example of how sayings get twisted ; but in that statement he is quite wrong. The appearance is almost universally held to be a sign of bad weather. Two explanations have been offered to account for the prognostic, in each of which there is undoubtedly a measure of truth. When the moon appears "new" to us, the earth would appear "full" to the lunar inhabitants, if there were any ; and what causes the dark part of the young moon to be dimly visible is its reflection of the brilliant earth-shine. The earth, however, will not always shine with equal brilliance, even when the same amount of surface is illuminated, for obviously clouds reflect more light than either land or sea. Hence, when an unusual illumination of the night-side of the moon is apparent, it shows that the earth-shine is exceptionally strong, which in turn is an indication of the presence of a large amount of cloud in our atmosphere. Further, as a moment's consideration will prove, the cloud area must lie to the west of us, the direction from which we receive most of our storms; so that the apparition of the old moon in the arms of the new, virtually means that there are vast cloud-banks over the North Atlantic Ocean which, in all probability, are drifting up to us, and will, before long, bring us "dirty" weather. I am not disposed to go so far as Mr. John Aitken, who, in a paper recently read before the Royal Society of Edinburgh, suggested the use of the moon's dark limb as an "outlying signal station," but it is satisfactory to know that this venerable prognostic has a sound physical basis, and is as worthy of respect as ever it was. The other explanation to which I referred is the greater "visibility" of the air which generally precedes rough or unsettled weather, this clearness allowing the ghostly disk of the old moon to loom forth in a way it could not do through a misty atmosphere. Though, doubtless, a part explanation of the phenomenon, it is not a whole one, and must be taken along with the other.

The halo is an old sign of bad weather:

"When round the moon there is a brugh,
The weather will be cold and rough."

Of sixty-one lunar halos observed in the neighborhood of London, thirty-four were followed by rain within twenty-four hours, nineteen by rain within four days, and only eight by no rain at all. The cause of halos is the formation of an extremely attenuated form of cloud which floats in the van of all cyclonic disturbances. Messrs. Abercromby and Marriott, who made a detailed comparison between a number of popular weather prognostics and the actual distribution of weather as disclosed by synoptic charts, found the lunar halo to be a true sign of the approach of a "cyclone" or area of depression, just as a clear moon indicates the presence of an anti-cyclone, or area of high pressure, with the likelihood of cold or frost. Similarly, a pale or watery moon marks the advent of a disturbance, while the blunting of the cusps is due to the same cause, and has the same significance. The variation of this last prognostic, which makes a sullied lower horn the sign of foul weather before the full, and a sullied upper horn the sign of foul weather about the wane, is purely fanciful.

Just one word about that enticing object of research—as fascinating in its way as perpetual motion or the exact value of π—the lunar circle.

Dr. E. B. Tylor, says: "The notion that the weather changes with the moon's quarterings is still held with great vigor in England. That educated people to whom exact weather records are accessible should still find satisfaction in the fanciful lunar rule, is an interesting case of intellectual survival." I am willing to be with the foremost in combating such absurdities as "Herschel's Weather Table," and all theories which would assign to the lunar phases an immediate control of our weather; but it so happens that the notion Dr. Tylor condemns is one for which there may be some foundation. A moon's quarter is roughly equivalent to a week, and Mr. Carpmael, the Director of the Canadian Meteorological Department, once told me that he had very frequently noticed a tendency in the weather to change and repeat itself every seven days. A similar seven-day periodicity has been observed in the United States. The meteorological conditions of a large continent, it must be remembered, are simpler than those of our own little islands, and hence it is possible that a cycle almost completely masked here might disclose itself there. It is not to be supposed that I am contending for a cycle due to the moon. I only wish to point out that there is some evidence of the existence of a seven-day weather period, which may sometimes happen to be coincident with the lunar phases ; and if this be really so, it is not at all wonderful that our forefathers were led to infer a connection, or that even "educated people" continue to put a certain amount of faith in a rule so well founded.

But pre-eminently *the* lunar cycle is that of eighteen and a half years—the ancient Saros, or period of revolution of the lunar node. It has been traced in sundry phenomena, including the amount of rainfall and the recurrence of epidemic pestilences. The evidence, of course, is extremely shaky, though scarcely more so than much of that adduced in favor of the sun-spot cycle. The truth seems to be that in certain lines of inquiry, if an investigator starts with a predetermined system of any kind, statistics will bear him out, or can be made to bear him out.

In closing this hasty survey of a branch of mixed knowledge and ignorance, science combined with superstition, I would repeat the observation with which I set out (and which I have now in a measure justified), that it is unfair to stigmatize the whole moon-and-the-weather theme as unworthy of serious treatment—as a mere surviving fragment of astrology. There is a great deal of nonsense in it, more nonsense than sense ; and if the two must sink or swim together, it would be better to let the sense go than to preserve both. But why should they be inseparable? We have sifted a little grain out of much chaff before now ; and there is this great gain in the result, that the sifted chaff *is* chaff, obviously, demonstrably, and can not lay claim to a spurious value in the eyes of the short-sighted by the admixture of a proportion of the valued thing. There are weather wiseacres who *know* that there is truth in some of their cherished lunar proverbs ; and the unconditional repudiation of every saying with moon in it by men of science simply convinces these old fellows that the men of science do not understand what they are talking about, and makes them cling all the more vigorously to their ill-used beliefs. If we were to set about it in a different way, and to accept the sayings that science can sanction, and only repudiate the rest, we would have a better chance of success in combating this irrepressible error. For it is the truth in the error that makes it irrepressible.—*Longman's Magazine.*

ANIMAL AGENCY IN SOIL-MAKING.

By Professor N. S. SHALER.

THE admirable studies of Mr. Darwin on the influence of earth-worms upon the soil has made it clear that these animals exercise a most important effect in its preparation for the use of plants. Mr. Darwin's luminous essay has served to call attention to the effect of organic life on the development of the soil-coating. In the following pages I propose to submit the results of some studies of a general nature, which serve to show that a number of other animals have a considerable influence on the preparation of soils.

Our soils, as is well known, depend upon a variety of actions which serve to break up the rocky matter of the earth, and to commingle that matter with organic materials more rapidly than the erosive agents can remove the *detritus* from the point at or near which it decays. For the formation of the soil two actions, at least, are essential. First, the bed-rock must be broken into fragments sufficiently separated from each other to permit the passage of roots between them; second, the rock fragments must be still further comminuted and commingled with organic waste to make the combination of organic and inorganic matter on which the utility of the soil absolutely depends. Although the earth-worms are undoubtedly very important agents in overturning and breaking up of soil, it appears to me that they are most effective in the tilled fields or in the natural and artificial grass-lands. So far as I have been able to observe, these creatures are rarely found in our ordinary forests where a thick layer of leaf-mold, commingled with branches, lies upon the earth. The character of this deposit is such that the creatures are not competent to make their way through it, and they therefore in the main avoid such situations. Moreover, wherever the soil is of a very sandy nature, earth-worms are scantily found if they are present at all. These worms are practically limited to the soils of a somewhat clayey character, which have no coating of decayed vegetation upon them.

As the greater portion of the existing soil has been produced in forest regions, I shall first examine the action of various animals upon the soils of wooded countries. The mammals are, of all our vertebrates, the most effective in their action upon the soil of forests. Twenty species or more of our American mammals are burrowers in the forest-bed. They either make their habitations beneath the ground, or resort to it in the pursuit of food. Of these, our burrowing rodents are perhaps the most effective, but a large number of other small mammals resort to the earth and make considerable excavations. In forming their burrows, or in the pursuit of other burrowing animals, these creatures often penetrate through the whole or greater portion of the soil-covering. The material which is withdrawn from the burrow is accumulated about its mouth. The result is the overturning of a considerable amount of the earth, and a consequent commingling of the material with vegetable matter. When brought to the surface and left exposed to the action of frost, the breaking up of the material is greatly favored, and thus the formation of the soil is facilitated.

Considerable as is the effect of burrowing mammals, the principal overturning of the earth in our primeval forests is accomplished by the invertebrate animals. Where the woods are not very dense, and particularly where the soil is somewhat sandy, our largest species of ants are very effective agents in working over the soil. Their burrows extend to the depth of some feet below the surface, and each hill brings to the air several cubic feet of excavated matter, which, as slight inspection shows, is much commingled with vegetable matter. Wherever these ant-hills abound they commonly exist to the number of a score or more on each acre, and the occupants of each hill, in many cases, bring as much as a cubic foot of matter to the surface in the course of a single year. The action of rain constantly operates to diffuse this material on every side of the hill. We may often observe a thin layer of sediment extending for a considerable distance from the elevation.

As is well known to all those who have inspected the soil within virgin forests, the earth is occupied by a host of larval insects, principally belonging to the group of beetles, but including also many orthopterous insects. These creatures, in the course of their life underground, displace a good deal of soil, a portion of which is thrown upon the surface, the greater part, however, being merely dislodged beneath the surface. The effect, however, is to commingle and to break up the soil, and thus favor its comminution. Although the roots of trees do by far the larger part of the rending which is accomplished in the soil-layer, they do not bring about much commingling of the soil. The thrusts which they apply to it shear the materials about, and so, to a certain extent, mix them, but by far the larger part of the commingling is effected by the animal life which dwells beneath the forest-bed.

Where the woods are wet and favor the development of the cray-fish, the effect of this group of animals on the overturning of the soil is extremely great. It probably exceeds that which is accomplished in our ordinary fields by the action of the earth-worms. A single cray-fish will often bring in the course of a single season's activity not less than half a cubic foot of earthy matter to the surface. In certain districts where these animals abound, there appear to be not less than a thousand to each acre of surface. If such be their number, it is evident that not less than five hundred cubic feet of matter is brought to the surface from a considerable depth in the course of a year. As this matter is generally of a rather fine nature and easily dissolved in water, it rapidly washes away and forms a thin sheet on the surface.

I am inclined to believe that large areas of our wet woods and the open border-lands along our streams are completely overturned to the depth of two feet or more in the course of half a century by the actions of these animals. It is not impossible, indeed, that the very fine division of the soil which characterizes the regions inhabited by these creatures may be in good part due to their action. In this manner the creatures may have in part worked to bring about the very conditions which best serve their needs.

In open grounds, in natural prairies or grass-plains, the smaller species of ants are extremely effective agents in overturning the soils. Wherever the ground remains for some time unplowed it becomes occupied by these creatures. In the sandy soils of Eastern Massachusetts, the overturning accomplished by these creatures assumes a geological importance. For many years I have been puzzled by the fact that the glacial terraces and plains of this region were extensively covered to the depth of a foot or more by a coating of fine sand and very small pebbles, while below the depth of a foot pebbles of larger size are very numerous, and the spaces between them but imperfectly occupied with any material. It is obviously impossible to explain these conditions through the action of earth-worms, for the reason that these creatures are rarely found in soils of this description. From much observation I have become convinced that this coating of sandy material is, to a great extent, to be explained by the action of various species of ants in the forest condition by the work of the larger black ants, and in the condition of open plains by that of the smaller species.

The amount of material which these creatures bring to the surface in a single season is surprising. At several points in Eastern Massachusetts I have found the surface to contain at least one ant-hill to each square foot of area, or about forty thousand hills to the acre. This is, probably, an exceptionally great number; it will, perhaps, be safer to estimate the number at twenty thousand to the acre. The incoherent heaps of excavated matter which these creatures form are quickly washed away by the rain, or in many cases, are blown away by strong winds, and so scattered over the surface. As soon as destroyed they are, in most cases, rebuilded, the result being that a single hill is reconstructed at least half a dozen times during a season. I have estimated that the amount of material brought to the surface often exceeds three cubic inches to each square foot of surface in a single year, or about a fiftieth of an inch of the whole area each year. Thus, in the term of fifty years, the accumulation of material on the surface would amount to as much as an inch, and reckoning the soil as having an average depth of one foot, a total overturning would be accomplished in less than a thousand years. It is likely that in some cases, over considerable areas, a tolerably complete overturning is brought about in less than a quarter of this time.

The effect of this action of ants on the soil-material is peculiar. The tendency is like that noted by Mr. Darwin in the case of earth-worms to bring the finer particles to the surface. I am inclined to think the ants accomplished this part of their work even more effectively than the earth-worms, for the reason that they penetrate more deeply between the stones than their less active associates. Like the earth-worms, but in larger measure, the ants convey considerable amounts of organic matter into the soil. Their winter store of food is deeply buried, and much of it remains unconsumed in the nether earth. There is thus a constant inhumation of vegetable matter beneath the materials which they bring to the surface.

Although the burrowing vertebrates operate most vigorously in the forest-covered regions, they also exercise a certain influence on the open country. The moles which work only here and there in the forest are conspicuous agents in overturning the soil in the grassed regions. Still, as this group is peculiarly limited in its distribution, and rarely penetrates to more than four or five inches below the surface, it exercises a relatively small effect. The field-mice are more potent agents in effecting the character of the soil. Their dwelling-chambers are at a considerable depth below the surface, and in forming them, they bring a certain amount of matter to the open air, moreover the remains of their food, as well as their excrements, are important contributions to the organic matter of the soil. Insects in their larval stage exercise a less effect in the open field than in the forest-covered regions; still, they are not to be left out of account in considering the process of soil-making in such areas. In Europe the rabbit, which has a habit of burrowing to a considerable depth, and in certain districts west of the Mississippi, the prairie-dog, overturn the soil on the areas they occupy with considerable rapidity. Still, as the number of these creatures in any given district is not great, their influence is mostly exercised in a very local way.

The foregoing considerations make it tolerably clear that our ants are, in some districts, by far the most important agents in overturning the soil and in commingling the superficial organic matter with the mineral material of which it is composed. Although on a field of a certain class those which are of a clayey nature, the earth-worms, are probably more efficient soil-makers than the ants, this latter group appears to be, at least in the eastern part of North America, on the whole, by far the most effective in the preparation of the soil for the needs of plants. They do not, it is true, take the soil into their bodies and thus disintegrate it, as the earth-worms do, but they accomplish what is perhaps the more important task of rapidly overturning the soil-material as well within the forests as in the open fields wherever that material is of a sandy nature.

THE TIME IT TAKES TO THINK.

By J. McK. CATTELL.

ALL science is partly descriptive and partly theoretical. Care must, however, be taken lest too much theory be built up without sufficient foundation of fact, or there is danger of erecting pseudo-sciences, such as astrology and alchemy. The theories of the conservation of energy and of the evolution of species are more interesting to us than the separate facts of physics and biology, but facts should be gathered before theories are made. The way of truth is a long way, and short cuts are apt to waste more time than they save. Psychology is the last of the sciences, and its present business seems to be the investigation of the facts of consciousness by means of observation and experiment. Everywhere in science experiment is worth more than observation; it is said that the evidence in pathology is so contradictory that almost anything can be proved by clinical cases. Psychology, owing to its very nature, must always depend largely on observation for its facts, and some progress has been made in spite of the difficulties lying in the way of introspection and the correct interpretation of the actions of others. The application of experimental methods to the study of mind is, however, an important step in advance, and would seem to be a conclusive answer to those who, with Kant, hold that psychology can never become an exact science. I propose explaining here how we can measure the time it takes to think, and hope this example may show that the first fruits of experimental psychology are not altogether insignificant or uninteresting. Just as the astronomer measures the distance to the stars and the chemist finds atomic weights, so the psychologist can determine the time taken up by our mental processes. It seems to me the psychical facts are not less important than the physical; for it must be borne in mind that the faster we think, the more we live in the same number of years.*

It is not possible directly to measure the time taken up by mental processes, for we can not record the moment either of their beginning or of their end. We must determine the interval between the production of some external change which excites mental processes, and a movement made after these processes have taken place. Thus, if people join hands in a circle, and one of them, A, presses the hand of his neighbor B, and he as soon as possible afterward the hand of C, and so on round and round, the second pressure will be felt by each of the persons at an interval after the first, the time depending on the number of people in the circle. After the hand of one of the persons

* The results I am about to give are based on experiments, detailed accounts of which I have printed in recent volumes of "Mind," "Brain," and "Philosophische Studien."

has been pressed an interval very nearly constant in length passes before he can press the hand of his neighbor. This interval, which we may call the reaction-time, is made up of a number of factors. A period elapses before the pressure is changed into a nervous message or impulse. This time is very short in the case of touch; but light working on the retina seems to effect chemical changes in it, and these take up some little time, probably about one fiftieth of a second. After a nervous impulse has been generated it moves along the nerve and spinal cord to the brain, not traveling with immense rapidity like light, but at the rate of an express train. In the brain it must move on to a center having to do with sensation, where changes are brought about, through which a further impulse is sent on to a center having to do with motion, and a motor impulse having been prepared there is sent down to the hand. Another pause, one two hundredth to one one hundredth of a second, now occurs, while the muscle is being excited, after which the fingers are contracted and the reaction is complete. The entire time required is usually from one tenth to one fifth of a second. The reaction-time varies in length with different individuals and for the several senses, but as long as the conditions remain the same the times are very constant, only varying a few thousandths of a second from each other. One may wonder how it is possible to measure such short times and with such great accuracy. It would not be easy if we had not the aid of electricity; but when it is called to mind that a movement made in London is almost instantaneously registered in Edinburgh, it will not seem inconceivable that we can record to the thousandth of a second the instant a sense-stimulus is produced and the instant a movement is made. The time passing between these two events can be measured by letting a tuning-fork write on a revolving drum. The tuning-folk can be regulated to vibrate with great exactness, say five hundred times a second; it writes a wavy line on the drum, each undulation long enough to be divided into twenty equal parts, and thus time can be measured to the ten thousandth of a second.

The psychologist is chiefly interested in what goes on in the brain and mind. It seems that about one half of the entire reaction-time is spent while brain changes take place, but we know very little as to these changes, or as to how the time is to be allotted among them. It is probable that in the case of the simple reaction the movement can be initiated before the nature of the impression has been perceived. We can, however, so arrange the conditions of experiment that the observer must know what he has seen, or heard, or felt, before he makes the movement. He can, for example, be shown one of a number of colors, and not knowing beforehand which to expect, be required to lift his finger only when red is presented. By making certain analyses and subtracting the time of the simple reaction from the time in the more complex case, it is possible to determine with considerable accuracy the time it takes to *perceive*, that is, the time passing from the moment at which an impression has reached consciousness until the moment at which we know what it is. In my own case about one twentieth of a second is needed to see a white light, one tenth of a second to see a color or picture, one eighth of a second to see a letter, and one seventh of a second to see a word. It takes longer to see a rare word than to see a common one, or a word in a foreign language than one in our native tongue. It even takes longer to see some letters than others.

The time taken up in choosing a motion, the "will-time," can be measured as well as the time taken up in perceiving. If I do not know which of two colored lights is to be presented, and must lift my right hand if it be red and my left hand if it be blue, I need about one thirteenth of a second to initiate the correct motion. I have also been able to register the sound-waves made in the air by speaking, and thus have determined that in order to call up the name belonging to a printed word I need about one ninth of a second, to a letter one sixth of a second, to a picture one quarter of a second, and to a color one third of a second. A letter can be seen more quickly than a word, but we are so used to reading aloud that the process has become quite automatic, and a word can be read with greater ease and in less time than a letter can be named. The same experiments made on other persons give times differing but little from my own. Mental processes, however, take place more slowly in children, in the aged, and in the uneducated.

It is possible, further, to measure the time taken up in remembering, in forming a judgment, and in the association of ideas. Though familiar with German, I need, on the average, one seventh of a second longer to name an object in that language than in English. I need about one quarter of a second * to translate a word from German into English, and one twentieth of a second longer to translate in the reverse direction. This shows that foreign languages take up much time even after they have been learned, and may lead us once more to weigh the gain and loss of a polyglot mental life. It takes about two fifths of a second to call to mind the country in which a well-known town is situated, or the language in which a familiar author wrote. We can think of the name of next month in half the time we need to think of the name of last month. It takes on the average one third of a second to add numbers consisting of one digit, and half a second to multiply them. Such experiments give us considerable insight into the mind. Those used to reckoning can add two to three in less time than others; those familiar with literature can remember more quickly than others that Shakespeare wrote "Hamlet." In the cases which we have just been considering a ques-

* In all cases the time of association only is given, the time needed to see the one word and name the other having been subtracted.

tion was asked admitting of but one answer, the mental process being simply an act of memory. It is also possible to ask a question that allows of several answers, and in this case a little more time is needed; it takes longer to mention a month when a season has been given than to say to what month a season belongs. The mind can also be given still further liberty; for example, a quality of a substantive, of a subject or object for a verb, can be required. It takes about one tenth of a second longer to find a subject than to find an object; in our ordinary thinking and talking we go on from the verb to the object. If a particular example of a class of objects has to be found, as "Thames" when "river" is given, on the average a little more than half a second is needed. In this case one nearly always mentions an object immediately at hand, or one identified with one's early home; this shows that the mind is apt to recur either to very recent or to early associations. Again, I need one second to find a rhyme, one fifth of a second longer to find an alliteration. The time taken up in pronouncing an opinion or judgment proved to be shorter than I had expected; I need only about half a second to estimate the length of a line, or to say which of two eminent men I think is the greater.

Our thoughts do not come and go at random, but one idea suggests another, according to laws which are probably no less fixed than the laws prevailing in the physical world. Conditions somewhat similar to those of our ordinary thinking are obtained, if on seeing or hearing a word we say what it suggests to us. We can note the nature of the association and measure the time it takes up, and thus get results more definite and of greater scientific value than would be possible through mere introspection or observation. By making a large number of experiments, data for laws of association can be collected. Thus, if a thousand persons say what idea is suggested to them by the word "Art," the results may be so classified that both the nature of the association and the time it occupies throw much light on the way people usually think. Such experiments are useful in studying the development of the child's mind; they help us to understand the differences in thought brought about by various methods of education and modes of life, and in many ways they put the facts of mind into the great order which is the world.—*Nineteenth Century*.

Recognizing that the surface of the earth will in a few years be all explored for ordinary geographical purposes, Professor Boyd Dawkins has called attention to the fact that besides the geography in space, there is a nearly untouched field of geography in time. It concerns the ancient changes by which the earth's surface has come to be what it is, and the geographical outlines as they appeared at the various geological periods. In working this field geographers would do as good geographical work as in recording any of the facts which are brought from the interior of Africa or from the polar regions.

WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

[*Concluded.*]

TO those who have already been startled by the memoir of Dr. W. Baldwin Spencer on the presence and structure of the pineal gland in Lacertilia, and the evidence that it represents a third eye in a rudimentary condition, it will be interesting to know that among some of the earlier mammals the pineal gland may have assumed functional importance as an eye. Professor Henry F. Osborn † shows that in the skull of the curious mammal Tritylodon, of Owen, there is seen a parietal foramen in exactly the same position and relation as in the lizard Sphenodon.

Professor Osborn regards this fact of remarkable interest, as it adds greatly to the rapidly accumulating evidence for the reptilian affinities of the mammalia. Professor Owen, in the description of this unaccountable opening, suggested that it might be due to posthumous injury.

Professor Marsh, ‡ in a description of the skull of Diplodocus, a Dinosaur, describes a fontanelle in the parietal on the median line directly over the cerebral cavity. He adds, however, that this may be merely an individual variation.

Professor Cope # observes an enormous fronto-parietal foramen in the skull of *Empedocles molaris*, a curious creature from the Permian.

It would appear evident from these facts that at one time the pineal gland, which in the mammals is in a rudimentary condition, and in certain Lacertilia sufficiently perfect, as an eye, to be sensitive to light impressions at least, was, in certain extinct mammals and reptiles, of large size and functionally active. It is a significant fact that no sooner does some one opposed to evolution undertake to lay down the law by setting a boundary to type-features, than a discovery is made that breaks down the barrier. Thus, Dr. Thomas Dwight, ‖ in an interesting memoir on the "Significance of Bone Structure," in which he makes a brave defense for teleology, says, in speaking of the persistence of the vertebrate plan, "There are never, for instance, more than two eyes or one mouth or two pairs of limbs," and, lo ! an extra eye is immediately added.

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

† "Science," vol. ix, p. 114.

‡ "American Journal of Science and Arts," vol. xxvii, p. 161.

\# "Proceedings of the American Philosophical Society," 1878, p. 516.

‖ "Memoirs of the British Society of Natural History," vol. iv, No. 1.

Dr. Spencer Trotter* has made a study of the collar-bone and its significance, in which he accounts for its presence or absence in mammalia by correlating it with the life-habits of the animal in the use of the fore-limb. He says: "Every fully-developed tissue in an organism is needed, or it would not be there; and just so soon as by increasing change in life and habits it becomes a factor of less and less importance to the animal, it fails more and more to attain its former standard of development, and in time falls back to the primitive condition from which it arose and finally disappears."

Many new and interesting facts have been added sustaining the affinity between the birds and reptiles. Professor O. C. Marsh † made a careful study of the Archæopteryx in the British Museum. The new points he has added bring out still more strongly the extraordinary characters blended in this creature. Among other features he discovered the separate condition of the pelvic bones, and shows that while it must be considered a bird, yet it has true teeth, bi-concave vertebræ, three separate fingers in each hand, all furnished with claws, metatarsals and metacarpals, equally unanchylosed and the pelvic bones separate, as already mentioned.

Dr. J. Amory Jeffries,‡ in the study of the claws and spurs on birds' wings, has presented an interesting table showing the number of phalanges in each finger, from the highest to the lowest family of birds, with the presence or absence of claws recorded for each finger. This table shows very clearly that the higher birds have fewer phalanges and no claws, and as one approaches the lower families the phalanges increase in number, the first finger having two phalanges, and the second and third fingers being tipped with claws.

In a brief study of the tarsus of low aquatic birds,# made with special reference to the interpretation of the ascending process of the astragalus with the intermedium of reptiles, I observed a separate center of ossification for this so-called process, observed its unquestionable position between the tibiale and fibulare, its increase in size with the growth of the bird, and its final anchylosis with the proximal tarsal bones. In the bones of a young Dinornis, which through the courtesy of Dr. Henry Woodward I was kindly permitted to examine in the British Museum, the ascending process was large and conspicuous and firmly anchylosed with the coössified tarsals to the distal end of the tibia. Professor Marsh,‖ in a study of the metartasal bones of Ceratosaurus, a Dinosaur discovered by him, found that the metatarsals coössified in the same manner as those of the penguin.

The question as to the existence of a sternum in Dinosaurian

* "American Naturalist," vol. xix, p. 1172.

† "American Journal of Science and Arts," vol. xxii, p. 338.

‡ "Proceedings of the British Society of Natural History," vol. xxi, p. 301.

\# "Anniversary Memoirs of the British Society of Natural History," 1880.

‖ "American Journal of Science and Arts," vol. xxviii, p. 161.

reptiles has long been in doubt. Professor Marsh * has, however, discovered in Brontosaurus, one of the largest known Dinosaurs, two flat bones which he regards as clearly belonging to the sternum. They correspond to the immature stage of similar parts in birds.

Dr. Alexander Agassiz,† in a study of the young stages of certain osseous fishes, shows that while the tail is a modified heterocercal one, it is for all that in complete accordance with embryonic growth and paleontological development ; and, independently, Dr. John A. Ryder ‡ finds that "the median fins of fishes normally present five well-marked conditions of structure which correspond inexactly to as many stages of development, which, in typical fishes, succeed each other in the order of time."

Mr. James K. Thatcher, # in a study of the "Median and Paired Fins, a Contribution to the History of Vertebrate Limbs," shows that "the limbs, with their girdles, were derived from a series of similar simple parallel rays, and that they were a specialization of the continuous lateral folds or fins evidenced in embryos, which were, with some probability, homologous with the lateral folds or metapleura of the adult Amphioxus."

A great amount of work has been done in making clear the earlier stages in the development of animals, and breaking down the hard and fast lines which were formerly supposed to exist between the larger divisions. Dr. C. S. Minot, ‖ in a series of papers on "Comparative Embryology," in referring to the work accomplished, says: "These researches have completely altered the whole science of comparative anatomy and animal morphology, by entirely upsetting a large part of Cuvier's classification and the idea of types upon which it was based, substituting the demonstration of the fundamental identity of plan and structure throughout the animal kingdom, from the sponges to man."

Professor C. O. Whitman,[^] in describing a "rare form of the blastoderm of the chick, in which the primitive groove extended to the very margin of the blastoderm, terminating here in the marginal notch first observed by Pander," justly contends that, "in the origin of the embryo from a germ-ring by the coalescence of the two halves along the axial lines of the future animal, and, secondly, in the metameric division which followed in the wake of the concrescence," we have evidence of the annelidan origin of the vertebrates, since concrescence of the germ-bands is a well-established fact for both chætopods and leeches.

* "American Journal of Science and Arts," vol. xix, p. 395.

† "Proceedings of the American Academy of Arts and Sciences," vol. xiii, p. 117.

‡ "American Naturalist," vol. xix, p. 90.

\# "Transactions of the Connecticut Academy of Arts and Sciences," vol. iii, p. 281.

‖ Ibid., vol. xiv, p. 96.

^ "Proceedings of the British Society of Natural History," vol. xxii, p. 178.

The tracing of apparently widely divergent structures to a common origin has engaged the attention of many of our investigators. Not only has a large amount of evidence been offered to show a common origin of widely-separated structures, but memoirs of a speculative and theoretical character have given us a possible clew to the avenues we may follow in further establishing a proof of the unity of origin of forms and parts.

Dr. Francis Dercum * gives an interesting review of the structure of the sensory organs, and urges that the evidence goes to prove the common genesis of these organs.

Professor A. Hyatt † has presented an interesting study of the larval history of the origin of tissue. He attempts to show a phyletic connection between the Protozoa and Metazoa, and also to show that the tissue-cells of the latter are similar to a sexual larvæ, "and are related by their modes of development to the Protozoa, just as larval forms among the Metazoa themselves are related to the ancestral adults of the different groups to which they belong." Dr. John A. Ryder ‡ has studied the law of nuclear displacement and its significance in embryology. In a discussion of this subject he says: "The mode of evolution of the yolk is of great interest, and doubtless occurred through the working of natural selection. It is evidently adaptive in character, and the necessity for its presence as an appendage of the egg grew out of the exigencies of the struggle for existence."

Mr. H. W. Conn,# in a paper entitled "Evolution of the Decapod Zoæ," gives a number of striking and suggestive facts explaining the reason of the multiform and diverse character of the larvæ of decapod crustaceans. He shows in what way natural selection has affected the young. What has seemed an almost insoluble mystery, as to why the early stages of closely allied crustaceans should be so often diverse in their varied armature of long spines, their powers of rapid flight, etc., are explained on the ground of natural selection. In another memoir by the same author, ‖ on the significance of the "Larval Skin of Decapods," a very complete discussion of the views of authors is given. At the outset he shows that the crustaceans are a particularly favorable group for the study of phylogeny, and then suggests the character of the ancestral form of the Crustacea from the significance of the larval envelope. The author infers, from his studies, that "all decapods are to be referred back to a form similar to the *Protozoæ* (*Zoæ*), in which the segments of the thorax, and probably of the abdomen, were present, and whose antennæ were locomotive organs."

Not the slightest justice can be done this admirable discussion in the

* "American Naturalist," vol. xii, p. 579.

† "Proceedings of the British Society of Natural History," vol. xxiii, p. 45.

‡ "Science," vol. i, p. 273.

\# Ibid., vol. iii, p. 513.

‖ "Studies from Biological Laboratory," Johns Hopkins University, vol. iii, No. 1.

brief reference here made, but the perusal of it will certainly impress one with the profound change which has taken place in the method of treating a subject of this nature compared to the treatment it might have received in pre-Darwinian days. Indeed, the features discussed in this paper would not have attracted a moment's attention from the older naturalists.

Since Darwin published his provisional theory of Pangenesis it has provoked speculative efforts on the part of some of our naturalists to devise other hypotheses which might answer some of the objections urged against Darwin's hypothesis. Space will permit only a mention of a few of these papers. Professor W. K. Brooks * presented, in brief abstract, at the Buffalo meeting eleven years ago, a provisional theory of Pangenesis. These views, more elaborated, are now published in book-form, under the title of "The Laws of Heredity." An illustrious reviewer says it is the most important contribution on the speculative side of Darwinism that has ever appeared in this country. He has also aptly termed studies of this nature molecular biology. Dr. Louis Elsberg at the same meeting also read a paper on the plastidule hypothesis.

Dr. John A. Ryder † has made an interesting contribution entitled "The Gemmule *versus* the Plastidule as the Ultimate Physical Unit of Living Matter." In this paper he discusses Darwin's provisional theory of Pangenesis, and shows it to be untenable from Galton's experiments.

Haeckel's provisional hypothesis of the perigenesis of the plastidule is clearly stated, and he closes by saying that the logical consequences of the acceptance of Haeckel's theory, and with it the theory of dynamical differentiation—because the latter is no longer an hypothesis—forever relegate teleological doctrines to the category of extinct ideas.

The wide-spread public interest in Darwinism arose from the fact that every theory and every fact advanced in proof of the derivative origin of species applied with equal force to the origin of man as one of the species. The public interest has been continually excited by the consistent energy with which the Church—Catholic and Protestant alike—has inveighed against the dangerous teachings of Darwin. Judging by centuries of experience, as attested by unimpeachable historical records, it is safe enough for an intelligent man, even if he knows nothing about the facts, to accept promptly as truth any generalization of science which the Church declares to be false, and conversely to repudiate with equal promptness as false any interpretation of the behavior of the universe which the Church adjudges to be true. In proof of this sweeping statement, one has only to read the impos-

* "Proceedings of the American Associated Antiquarian Society," vol. xxv, p. 177; also "American Naturalist," vol. xi, p. 144.

† "American Naturalist," vol. xiii, p. 12.

ing collection of facts brought together by Dr. White, the distinguished ex-President of Cornell University, which are embodied in his work entitled "The Warfare of Science," as well as two additional chapters on the same subject, which have lately appeared in "The Popular Science Monthly." One then realizes the lamentable but startling truth that, without a single exception, every theory or hypothesis, every discovery or generalization of science has been bitterly opposed by the Church, and particularly by the Catholic Church, which resists, and, as Huxley says, "must, as a matter of life and death, resist the progress of science and modern civilization."

Only the briefest reference can here be made to a few of the numerous contributions on the subject of man's relationship to the animals below him. The rapidly-accumulating proofs of the close relation existing between man and the quadrumana, make interesting every fact, however trivial, in regard to the structure and habits of the higher apes.

Dr. Arthur E. Brown * has made some interesting experiments with the monkeys at the Zoölogical Gardens in Philadelphia. He found that the monkeys showed great fear, as well as curiosity, when a snake was placed in their cage, though they were not affected by other animals, such as an alligator and turtle. On the other hand, mammals belonging to other orders showed no fear or curiosity at a snake. These experiments, repeated in various ways, lead him to only one logical conclusion, "that the fear of the serpent became instinctive in some far-distant progenitor of man, by reason of his long exposure to danger and death in a horrible form, from the bite, and that it has been handed down through the diverging lines of descent which find their expression to-day in Homo and Pithecus."

The same author,† in an exceedingly interesting description of the higher apes, says: "Mr. A. R. Wallace once called attention to the similarity in color existing between the orang and chimpanzee and the human natives of their respective countries. It would, indeed, seem as if but half the truth had been told, and that the comparison might be carried also into the region of mind; the quick, vivacious chimpanzee partaking of the mercurial disposition of negro races, while the apathetic, slow orang would pass for a disciple of the sullen fatalism of the Malay."

Dr. Brown ‡ has also given a description of the grief manifested by a chimpanzee on the death of its mate. His grief was shown by tearing his hair or snatching at the short hair on his head. The yell of rage was followed by a cry the keeper had never heard before, a sound which might be represented by *hah-ah-ah-ah-ah* uttered somewhat under the breath, and with a plaintive sound like a moan.

Mr. W. F. Hornaday # read at the Saratoga meeting of this Asso-

* "American Naturalist," vol. xii, p. 225. † Ibid., vol. xvii, p. 119.
‡ Ibid., vol. xiii, p. 173. # Ibid., vol. xiii, p. 712.

ciation an exceedingly interesting paper on the "Habits of the Orang," as observed by him in his native forests. He says, "Each individual of the Borneo orangs differs from his fellows, and has as many facial peculiarities belonging to himself alone, as can be found in the individuals of any unmixed race of human beings." After recounting the many traits of the orang, heretofore regarded as peculiar to man, he says: "Let any one, who is prejudiced against Darwinian views, go to the forests of Borneo. Let him there watch from day to day this strangely human form in all its various phases of existence. Let him see it climb, walk, build its nest, eat and drink and fight like human 'roughs.' Let him see the female suckle her young and carry it astride her hip precisely as do the coolie women of Hindostan. Let him witness their human-like emotions of affection, satisfaction, pain, and childish rage—let him see all this, and then he may feel how much more potent has been the lesson than all he has read in pages of abstract ratiocination."

Professor W. S. Barnard several years ago, in a study of the myology of man and apes, showed that the scansorius muscle which Trail studied in the higher apes and which he supposed had no homologue in man, was really homologous with the *gluteus minimus* in man. Dr. Henry C. Chapman,* in a study of the structure of the orang-outang, has confirmed the truth of Barnard's discovery. Dr. Chapman is led to infer that the ancestral form of man was intermediate in character, as compared with living anthropoids or lower monkeys, agreeing with them in some respects and differing from them in others.

The osteological affinities which man has with the *Lemuridæ*, as insisted upon by Mivart, are also recognized by Cope.† In a general paper on the "Origin of Man and other Vertebrates," he says: "An especial point of interest in the phylogeny of man has been brought to light in our North American beds. There are some things in the structure of man and his nearest relatives, the chimpanzee, orang, etc., that leads us to suspect that they had rather come from some extinct type of lemurs."

It would seem as if we must look farther back than the higher apes for the converging lines of man's relations with them. The earliest remains of man or the apes found fossil, presenting as they do marked types with little tendency to approach one another, would in themselves suggest an earlier origin for both stocks.

In a paper by Professor Cope ‡ on "Lemurine Reversion in Human Dentition," he says, in concluding his article: "It may be stated that the trituberculur superior molars of man constitute a reversion to the dentition of the *Lemuridæ* of the Eocene period of the family *Anap-*

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1880, p. 163.

† "Popular Science Monthly," vol. xxvii, p. 609.

‡ "American Naturalist," vol. xx, p. 941.

tomorphidæ, and second, that this reversion is principally seen among Esquimaux and the Slavic, French and American branches of the European race."

In another paper by the same author* on the "Developmental Significance of Human Physiognomy," he compares the proportions of the body and the facial peculiarities of man with the higher apes and human infants, and shows that the Indo-European, on the whole, stands higher than the other races in the acceleration of those parts by which the body is maintained in an erect position, and in the want of prominence of the jaws and cheek-bones, which are associated with a greater predominance of the cerebral part of the skull and consequently greater intellectual power.

Dr. Harrison Allen,† in a study of the shape of the hind-limb as modified by the weight of the trunk, dwells on the manner of articulation in the gorilla of the fibula with both calcaneum and the astragalus, as well as the fact that the astragalus in that genus possessed a broad, deflected fibula facet, and says: "This peculiar projection is rudimental in the astragalus of civilized man, but was found highly developed in an astragalus from an Indian grave found at Cooper's Point, New Jersey."

In my Buffalo address, I alluded to a paper by Professor N. S. Shaler on the intense selective action which must have taken place in the shape and character of the pelvis in man on his assumption of the erect posture—the caudal vertebræ turning inward, the lower portion of the pelvis drawing together to hold the viscera, which had before rested on the elastic abdominal walls, the attending difficulty of parturition, etc. Dr. S. V. Clevenger‡ has since called attention to other inconveniences resulting from man's escape from his quadrumanous ancestors. In a paper entitled "Disadvantages of the Upright Position," he dwells particularly on the valves in the veins to assist the return of blood to the heart, which, considered from the usual teleological point of view, seems right enough; but why, he asks, should man have valves in the intercostal veins? He shows that in a recumbent position these valves are an actual detriment to the flow of blood: "An apparent anomaly exists in the absence of valves from parts where they are most needed, such as the venæ cavæ, spinal, iliac, hæmorrhoidal, and portal. The azygos veins have important valves. Place man upon 'all-fours,' and the law governing the presence and absence of valves is at once apparent, applicable, so far as I have been able to ascertain, to all quadrupedal and quadrumanous animals. Dorsad veins are valved; cephalad, ventrad, and caudad veins have no valves." By means of two simple diagrams he shows clearly the distribution of valved and unvalved veins as they exist in

* "American Naturalist," vol. xvii, p. 618.

† "Proceedings of the Philadelphia Academy of Natural Sciences," 1885, p. 383.

‡ "American Naturalist," vol. xviii, p. 1.

mammals, and why in man the same arrangement becomes detrimental. He dwells on the number of lives that are sacrificed every year by the absence of valves in the hæmorrhoidal veins. He also mentions other disadvantages in the upright attitude, as seen in the position of the femoral artery, even with man's ability to protect it. Its exposed condition is a dangerous element. Inguinal hernia of rare occurrence in mammals occurs very often in man, at least twenty per cent being affected. Strangulated hernia also causes many deaths. Prolapsus uteri and other troubles and diseases are referred to by Dr. Clevenger as due to the upright position. In other words, the penalties of original sin are in fact the penalities resulting from man's assumption of the erect posture.

In another paper by the same author,* on the "Origin and Descent of the Human Brain," he gives an interesting sketch of the phylogenesis of the spinal cord to its ultimate culmination in the development of the brain of man. He says that the most general interest centers in the large mass of cells and nerve-fibers called the cerebrum. "In the ornithorhynchus it is smooth and simple in form, but the beaver also has an unconvoluted brain, which shows at once the folly of attaching psychological importance to the number and intricacy of folds in animal brains. With phrenology, which finds bibativeness in the mastoid process of the temporal bone, and amativeness in the occipital ridge, the convolutional controversies must die out, as has the so-called science of palmistry, which reads one's fate and fortune in the skin-folds of the hand."

Professor Alexander Graham Bell † has presented a memoir to the National Academy on the "Formation of a Deaf Variety of the Human Race," in which he shows by tables a series of generations of certain families in which the progenitors being deaf-mutes this peculiarity becomes perpetuated in many of the descendants. Recognizing fully the laws of heredity, natural selection, etc., he shows that the establishment of deaf-mute schools, in which a visual language is taught which the pupils alone understand, tends to bring them into close association with one another; and that naturally, with this seclusion, acquaintance ripens into friendship and love, and that statistics show that there is now in process of being built up a deaf variety of man.

Dr. W. K. Brooks,‡ animated by the cogency of Professor Bell's reasoning, is led to prepare an article entitled "Can Man be Modified by Selection?" In this paper he discusses the startling proposition of Professor Bell, and recognizes the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race. The striking character of the tables of facts presented by Professor Bell, and the significant

* "American Naturalist," vol. xv, p. 513.

† "Memoirs of the National Academy of Science," vol. ii, fourth memoir.

‡ "Popular Science Monthly," vol. xxvii, p. 15.

suggestions of Dr. Brooks, lead one to consider how far the influence of selection has had to do with the character of great communities, as to their intelligence or ignorance. When we see nations of the same great race-stock, one showing a high percentage of illiterates, a high death-rate, degradation and ignorance, while just across the borders another nation, apparently no better off so far as physical environments are concerned, with percentage of illiterates and death-rate low, intelligent and cleanly, we are led to inquire if here a strict scientific scrutiny with careful historical investigation will not reveal the cause of these conditions. Can it be proved beyond question that the illiteracy and degradation of Italy and Spain, up to within recent years at least, is the result of centuries of church oppression and the Inquisition, destroying at once or driving out of the land all independent thinkers, and at the same time forcing her priests to lead celibate lives and inducing others of cultivated and gentle minds to lead cloister lives? Is it also a fact, as Alphonse de Candolle asserts, that by far the greater number of distinguished scientists have come from Protestant pastors? He gives a significant list of eminent men whose fathers were Protestant pastors, saying that, had they been priests of another religion, leading celibate lives, these men would not have been born.

It is considered an intrusion into matters which do not concern science when such inquiries are made, but the scientist has very deeply at heart the intellectual and moral welfare of the community. If the cause of degradation and ignorance, of poverty, of contagious disease, or of any of the miseries which make a nation wretched, can be pointed out by scientific methods, then it is the stern duty of Science to step in and at least show the reasons, even if the remedy is not at once forthcoming. The men who would be reformers and agitators, and who by their earnestness and devotion get the attention of multitudes, are unfit for their work if they show their ignorance, as most of them do, of the doctrines of natural selection and derivation.

Dr. C. S. Minot * read a paper before the Cincinnati meeting of this Association, suggesting a rather startling proposition as to whether man is the highest animal, which led Dr. W. N. Lockington † to reply in a very able article entitled "Man's Place in Nature."

The great problem of food-supply has led to legislative enactments for the purposes of regulating the trapping and netting of game and fish. State and Government grants have been made for fish commissions; but, unless the public are clearly educated in the rudiments of zoölogical science and the principles of natural selection, appropriations will come tardily and in limited amounts. Dr. W. K. Brooks, ‡ in his report to the State of Maryland as one of the oyster commissioners, after showing the absurd way in which the problem of oyster-protection has

* "Proceedings of the American Associated Antiquarian Society," vol. xxx, p. 240.

† "American Naturalist," vol. xvii, p. 1003.

‡ "Report of the Oyster Commissioners of Maryland," 1884, p. 31.

been dealt with, and strenuously urging the necessity of oyster-culture, calls attention to the fact that "civilized races have long recognized the fact that the true remedy is not to limit the demand, but rather to increase the supply of food, by rearing domestic sheep and cattle and poultry in place of wild deer and buffaloes and turkeys, and by cultivating the ground instead of searching for natural fruits and seeds of the forests and swamps."

Mr. Ernest Ingersoll,* author of the "Report on the Oyster-Industry," tenth United States census, has, in an address before the Geographical Society of New York, a striking sketch of the effect of the white man on the wild animals of North America, showing that, had the Indians remained in possession, little if any change would have taken place. The Indian, like the predaceous animals, hunts only for food, and shows even in this habit a wholesome self-restraint, never killing wantonly. He called attention to the survival of a number of small birds about the dwellings of man as the result of favorable conditions, such as a constant supply of food, etc. He shows that the contact of man in the main has been disastrous. His remarks on the oyster are timely; he shows its extermination along the coast by man's agency. "Hardly more than a century has elapsed since men believed that the oyster-beds of New York were inexhaustible, and that a small measure of legal protection, feebly maintained, was quite enough to sustain them against any chance of decay. So they thought in Massachusetts, where the oysters have not only disappeared but have been forgotten. So they think now in Maryland and Virginia, where their fond expectations are destined to equal downfall."

Professor William H. Brewer,† in a paper on the "Evolution of the American Trotting-Horse," shows that the trotter is an American product, and that it is still in process of evolution. He gives a column of figures to show the speed that has been attained in this new form of motion, from a speed of three minutes in 1818 down to two minutes ten and a quarter seconds in 1881. The materials for a curve is offered to mathematicians, and Professor Francis E. Nipher,‡ in a mathematical article on the subject, shows that a definite time of ninety-one seconds will ultimately be attained by the American trotter! Mr. W. H. Pickering,# however, urges some objections to the deductions of Professor Nipher.

In drawing to a close this very imperfect summary of what American zoölogists have accomplished for evolution many other distinguished contributors might have been mentioned. The work of eminent physiologists and paleontologists has hardly been considered,

* "Bulletin of the American Geographical Society," 1885, No. 1.

† "American Journal of Science and Arts," vol. xxv, p. 299.

‡ "St. Louis Academy of Sciences," May 7, 1883; also "American Journal of Science and Arts," vol. xxvi, p. 20.

\# "American Journal of Science and Arts," vol. xxvi, p. 378.

nor has the long array of botanical facts for Darwin as revealed in the fascinating study of the relations which exist between flowering plants and insects, contrivances for cross-fertilization, means of plant-dispersion, etc., and the distinguished botanists connected with this work, received attention here. Indeed, the proper limits for an address of this nature have been far exceeded.

Suffice it to say that all these students have worked from the standpoint of derivative doctrines. A still greater triumph to Darwinism are the evidences of gradual conversion still going on among a few isolated workers who still remain stubborn, yet yielding to the pressure of these views by admitting features that ten years ago they repudiated.

There are two points to be emphasized here in closing: and one is, that American biological science stands as a unit for evolution; and the other is, the establishment of a great generalization, which shows that when intelligence became a factor in animals, it was seized upon to the relative exclusion of other characteristics. This generalization offers an unassailable argument to-day for a wider, broader, and deeper education for the masses. The untold misery and suffering of the working-classes, as witnessed in their struggles of the last two years, would have been avoided had the rudiments of social science—even a knowledge of the value and significance of simple statistics—been appreciated by them.

The startling paper of Dr. Seaman* on the "Social Waste of a Great City" shows the blundering, criminal way in which municipalities are controlled by coteries ignorant alike of Science and the beneficent mission she stands waiting to enter upon.

[Within ten years a number of general works on evolution have appeared, the most important of which have been the "Law of Heredity" by Dr. W. K. Brooks, to which allusion has already been made; and the "Origin of the Fittest," by Professor E. D. Cope, in which are brought together the various papers, memoirs, addresses, etc., of the author which have appeared from time to time in scientific journals and magazines. Nearly all the addresses read, within the past ten years, before this Association by the presiding officers who were zoölogists have been imbued with Darwinism and deriviation. The titles of the general articles which have appeared on evolution would fill a large catalogue.

The general addresses on the subject are legion. Indeed, as the revered botanist Asa Gray has well remarked, "Dante literature and Shakespeare literature have been the growth of centuries, but Darwinism filled teeming catalogues during the lifetime of the author."

While no reference can be made to these various publications, allusions must be made to the Darwin Memorial Meeting of the Biologi-

* "Science," vol. viii, p. 283.

cal Society of Washington as containing a most appreciative *résumé* of the labors of the great naturalist. A perusal of the addresses on that occasion brings to mind very vividly the comprehensive scope of the work of this great man. The Introductory, by Professor Theodore Gill, is a strong sketch of the wonderful revolution wrought in the methods and convictions of naturalists by the doctrines of Darwin. Of great interest and value also are the succeeding addresses read at that meeting, which were—a "Biographical Sketch," by Dr. William H. Dall; "The Philosophical Bearings of Darwinism," by Major John W. Powell; "Darwin's Coral Island Studies," by Mr. Richard Rathbun; "Darwin's Investigations on the Relation of Plants and Insects," by Professor Charles V. Riley; "Darwin as a Botanist," by Mr. Lester F. Ward; "Darwin on Emotional Expression," by Mr. Frank Baker; closing with "A Darwinian Bibliography," by Mr. Frederick W. True.]

EMOTIONS *VERSUS* HEALTH IN WOMEN.

By MARY T. BISSELL, M. D.

WHEN the harassed and wretched Macbeth inquired of the doctor, "Canst thou not minister to a mind diseased?" his candid physician promptly disclaimed any such high qualifications. "Therein," said he, "the patient must minister to himself."

It is possible that the modern physician would appear less modest under a similar interrogation, since modern hygiene claims the entire man for its operations, concerning itself not only with his physical, but also with his mental good. Keenly alive to the intimate relations existing between mind and body, it often throws upon the physician of to-day the responsibility of determining whether the remedy indicated be chemical or spiritual. This broad outlook embraces large and small interests, and may certainly include one feature in the training of women which, we believe, is opposed to her best growth and health. We refer to a tendency which exists in her education to an undue stimulation of her emotional nature.

Woman is believed to have been endowed by Nature with a strongly emotional temperament. She is accepted as the fairest exponent of sentiments, which in turn lend her her chiefest charm. Tears and smiles, emotion and sensibility, are expected of her. It is permitted to her to be a blue-stocking if she will, but sympathetic and tender she must be. If Hypatia has her admirers, all the world loves Juliet! It is precisely in that natural aptitude for emotion, in that type of mind which is exquisitely sensitive to impressions and generously swayed by sympathetic feeling, that one of the great dangers to the perfection of womanhood, physical and mental, may be said to reside.

Many and varied influences tend to increase this emotional excitability until it often becomes a fixed habit of mind ; an undue sensibility of the supreme centers to emotional ideas is created, which can only be maintained at the expense of sound health of body and of mind. First among these are certain home influences that are brought to bear upon a little girl from her earliest childhood, which foster in her self-consciousness and introspection.

She is generally permitted narrower limits, within which she can play, can dress, can succeed, than are allowed to her brother, even when her physique is equally able. She is housed more closely, her out-of-door sports are fewer and less interesting, and her dress is too often a limitation to her freedom. Such restrictions of her liberty, and constant reference to the fact that her sex denies her this or that employment or pleasure, tend to make a child self-conscious and emotionally overactive. Methods of family discipline which depend upon appeals to the emotional natures of children have like unhealthy results, for they promote a condition of mental commotion and unrest harmful to children, who require an even atmosphere for the mind as well as for the body. There are often undue claims made upon little children for the demonstration of their affections, and this is especially true of girls.

In a paper on "Emotional Prodigality among Children," read before a dental society some years ago by Dr. C. F. Taylor, it was argued that stimulation of the emotions among children conduced not only to diseases of the spine, but also to dental caries.

Dr. Taylor says : "In my large practice among children, I am certain that scores are literally killed by the excessive amount of emotional excitement which they are forced to endure. All this hugging and kissing and talking to them is to excite responses of the same emotional nature in the child for the pleasure and gratification of the parents and friends." And again he says : "I believe that three fifths of the spinal diseases which occur in children are directly traceable to mental overaction. And this because a large proportion of these cases gets well without other treatment than a withdrawal from the exciting cause of emotional disturbance." The writer does not subscribe to this view of the causation of lateral curvature, except in so far as any influence which weakens the body may be a factor in this affection, but the opinion is of interest as suggesting the extent of this and kindred influences.

The literature which little girls are permitted to read may be held responsible for much emotional stimulation of an unhealthy character. If a man be known by the company he keeps, it is equally true that he is known by the books he reads. The last quarter of a century has opened a wide vista of healthful delight for children through the green fields of modern child literature, but the prospect is not yet entirely fair. The hot-house atmosphere prevails in many volumes, which owe their birth to the present decade.

I recall a very popular series of girls' books, widely read at the present time, in which the emotional natures of the little heroines are continually maintained at concert pitch from the strain put upon them by appeals to affection, to conscience, to inordinate love of praise, etc. I have often been astonished to see intellectually promising and otherwise sensible little girls devouring pages of unhealthy sentiment such as would fill their robust little brothers with scorn and repugnance.

We need only briefly refer to the unhealthy influence exerted upon the minds of little girls by foolish indulgence in showy dress or in social dissipation. Dissipation, indeed, is a serious term to apply to the social pleasures of little children, but, when we hear of children's parties beginning at nine o'clock, in which toilets and manners only suitable for their mammas are encouraged, we easily conclude that, in the lack of simplicity in social customs, we may find an abnormal stimulus to the emotional natures of American girls.

Certain school influences have a large responsibility in this direction. What is called the hot-house pressure of public schools, and the elaborate system of examinations in our higher institutions of learning, have their evil not in the exercise of the calmer faculties of the mind, such as judgment, reason, memory, etc., but in their tendency to arouse that complex emotion called *worry*. These influences are exerted, it is true, upon girls and boys alike, but, as the facility of the girls for emotional disturbance is greater, they suffer more largely per consequence. The repeated stimulation of such complex emotions can not fail to agitate the mind of young girls, and insidiously disturb its calm.

As the girl grows to womanhood, the impression made by these influences upon her plastic child nature can not be entirely thrown off. If she be of a strong and womanly type, she will meet the physical and social trials of life with such character and self-possession as she may, but they will have for such a one a double force. Life offers only too many facilities for overtaxing the sympathies of the unduly sensitized individual. The appeals of misery, poverty, and sorrow sound in every ear. The woman who would maintain a just equilibrium between sentimental mourning and efficient sympathy for these facts of existence needs to be re-enforced, not weakened, by the education of her childhood. And if to the friction of any life we add the strain of an elaborate social system, if our young woman be a society girl, with all the demands of a high-bred life of fashion upon her time, temper, versatility, and self-control, we have one more influence which maintains her at constantly high emotional pressure.

It is evident that the sum of these and similar forces constantly exerted upon the mind of women must have their due effect. The normal result of the stimulation of any organ of the body is well known to be a final loss of health in that organ. When the faculties of the mind, called out in the display of the emotions, are overtaxed, we generally find either a lack of will-power or a deficiency in reason and judgment, and our common expression for that condition is that such an individual is not well balanced.

It is possible that some of us have heard it suggested that woman is a less reasonable being than man. It has, indeed, been whispered that she—regarding her as a type, not as an individual—is less logical, less temperate in her judgments, more easily controlled by appeals to the feelings. In the recent article by Ouida in the "North American Review," speaking of the character of a woman's mind, she says: "The female mind has a radical weakness, which is often also its peculiar charm; it is intensely subjective; it is only reluctantly forced to be impersonal." Such opinions are not entirely unfamiliar to any of us.

We are in no wise concerned for the final judgment of mankind upon the mind of woman, nor do we imagine that it requires championship. But it is easily apparent that this very grace of her nature may be turned to bad account through undue stimulation, and that, through inheritance and the influences we have briefly suggested, she may acquire a tendency toward an unduly subjective type of mind—a tendency which threatens the loss of a just intellectual sense of proportion, and which, therefore, can not conduce to sound mentality.

The old meaning of the word emotion—*commotion*—is opposed to the best mental growth and health. In repose, in the quiet harmonious performance of its functions, the mind grows into vigorous maturity, and the constant unrest and commotion of nerve-elements, which accompany violent emotional disturbances, and repeated strain upon other than its reasoning faculties, can not fail to disturb the quiet, natural evolution of its powers. Can this tendency in woman's training be shown to affect her bodily health? Physicians and metaphysicians answer, Yes!

The intimate relation which exists between the mind and the body is a matter of familiar knowledge to us all. The tear that starts from the eye when grief disturbs the mind is a common instance of the effect which an intangible mental emotion has upon the physical basis of the lachrymal gland. The loss of consciousness and the heart-failure which may follow great mental shock, and the deleterious effect which mental anxiety may exercise upon digestion, are, unfortunately, matters of common experience. Even the poetical allusion to the hair which grows white in a single night has its basis in physiological fact. The miracles claimed by the faith-curers are in the same line of argument, for they indicate how far sedation of the mind may be an adjuvant to the cure of the body.

Says Maudsley: "It may be questioned whether there is a single act of nutrition which emotion may not affect, infecting it with feebleness, inspiring it with energy, and so aiding or hindering recovery from disease. It is certain that joy or hope exerts an animating effect upon the bodily life, quiet and equable when moderate, but when stronger, evinced in the brilliancy of the eye, in the quickened pulse, in an inclination to laugh and sing; grief, or other depressing passion has an opposite effect, relaxing the arteries, enfeebling the heart, making the eye dull, impeding digestion, and producing an inclination to sigh or weep." This exaggeration of the emotions, seen in many cases among women, may be considered a serious factor in inducing some of the most common diseases of the nervous system from which Americans, in particular, are suffering.

In his treatise on the causes of these nervous diseases Dr. Ross, of London, says: "Psychical disturbances are a prolific source of disease of the nervous system, and it is probable that as civilization advances these causes will exercise a more and more predominant influence in the production of nervous disease. The depressing passions, such as fright, alarm, disgust, terror, and rage, have, no doubt, in all ages, exerted a deleterious influence on the nervous system; but in the present day the keen competition evoked by the struggle for existence in the higher departments of social life must subject the latest evolved portion of the nervous system to a strain so great, that those only possessing the strongest and best balanced nervous system can escape unscathed." Of these nervous diseases, nervous exhaustion and hysteria were never more rife than to-day.

As regards the occurrence of hysteria, while it is frequently found among those belonging to what we call the lower classes of society, it is more frequently manifested among the more highly cultivated. A French author who, indeed, speaks for his own country only, states that one out of four of all females are decidedly affected with hysteria, and that one-half present an undue impressionability which differs very little from it. Although these statistics are too high for America, they are significant as being possible anywhere, and not the less so as coming from a land where, if a woman is anything, she is emotional.

Among the frequent causes of hysteria, all writers mention the depressing passions, such as fear, anxiety, jealousy, and remorse. One says: "The chief mental characteristic of hysterical patients is an excessive emotional excitability unchecked by voluntary exertion." And again: "This excessive emotional activity necessarily induces exhaustion." The treatment of this affection recognizes, first and last, the influence of mind over body. We find that moral suasion, the employment of the individual in directions without herself, the cultivation of an intellectual purpose, of an objective quality of mind, are remedies that rank with the nervines and antispasmodics in the treatment of this disorder.

As regards nervous exhaustion, we find that affection is almost entirely confined to the more highly civilized portions of the community —indeed, is a disease of civilization. Among the causes of nervous exhaustion this same truth is manifest—that excessive demands upon the individual exciting the complex emotions of anxiety, *worry*, are largely responsible for inducing this affection. We believe, indeed, that hard work, unaccompanied by emotional excitement, seldom injures either man or woman. It is the man who, in addition to close application to work, is harrassed by fears of poverty, of loss of position, of anxieties for himself or his family, and the woman who bears the burden of domestic cares, of private griefs, or sustains the strain of a complex social system, who suffers from nervous exhaustion, not the hard-working mechanic, or the unemotional washer-woman. The experience of every school-girl testifies that mental anxiety produces a degree of physical exhaustion out of all proportion to the muscular work effected. The agitations of school politics, the over-emotional character often infused into school-girl friendships, the fears of failure and kindred commotions result in more physical weariness than hours of calm, steady work in the laboratory or in the class-room.

A college graduate confesses that one of the most exhausting experiences of her college life was a morning spent in absolute physical inactivity in a student's meeting, but in a state of mental commotion impossible to describe, over an absorbing issue in college politics. "After four hours of that experience," she said, "I was fit for bed, and for nothing else." It requires no great ingenuity to suggest that this tendency in the training of woman which affects her mental and physical health, may be met by remedies addressed to body and mind alike. The education which shall discipline, not eradicate, the emotional susceptibility of women must begin where the gentility of Dr. Holmes's ideal gentleman began, with our great-grandmothers.

Heredity may not be able to shoulder all of the sins of mankind, but, at least, it must bear its share. The coming woman must not only be well-born, she must be bred in more hygienic methods. She must not only possess inherited vigor, she must also be educated nearer to Nature. The genuine child of Nature is not a morbidly emotional child. The girl who lives in the open air, who knows every bird and flower and brook in the neighborhood, has neither time nor inclination to spend in reading the sentimental histories of departed child-saints, and takes small delight in morbid conversation.

Out-of-door life has never been made popular or interesting for little girls as it always has been for boys. Girls will voluntarily seek fresh air and sunshine if they appreciate the delightful occupations as well as the *fun* to be found in it. They are quite right in "hating to go out because there is nothing to do." Open wide to them the fascinating book of Nature ; let them read the story of bird-life and animal-life, and find their first hints of the wonders of plants and rocks by sunlight, and at first hand, not from a printed page in unventilated libraries. Then, when out-of-door life and out-of-door sports have been made as attractive and popular for girls as for boys, and when they have accepted the creed that a nobly-developed and active body is as much their birthright and glory as it has always been the glory of their brothers, we shall find we have gone a long way toward reducing exaggerated emotions in women. And if our first antidote for this condition lies in physical activity and in the cultivation of a sound body, the second antidote will be found in the provision of constant, congenial employment for the mind.

When a young woman went to Henry Ward Beecher to ask him to prescribe for her disappointed affections, he promptly advised her to begin the study of the higher mathematics! There is no doubt but that among the less apparent, but no less real causes of undue emotional development among women we may count the lack of congenial and effective work. There is nothing sanitary in intellectual idleness. Physiology forbids that the inactive brain should be a healthy one. The overworked individual may suffer from undue strain, but the mind which is denied congenial employment suffers even a worse penalty in the disability of its best powers, and the waste of purposeless energy.

Women who are receiving the so-called higher education, find in its discipline and opportunity the best remedy for any tendency to excessive emotional disturbance. "The worst enemy of the emotions is the intellect." There is no stronger argument for opening to women new avenues for the acquisition of knowledge than these facts of her constitution offer, justified as the experiment has been by those who have found life a better and a broader thing to them because of these opportunities.

Undoubtedly the actual erudition that is gained in a collegiate training for women could be obtained under other conditions than in the four years of college life. But the inestimable value of our women's colleges lies not so much in their opportunities for actual learning, as in the atmosphere they offer. To live for four years under a *régime* where mental and physical energy are carefully utilized and disciplined, and where the tendency is toward the development of an objective type of mind and the cultivation of a broad intellectual outlook—these are incalculable benefits to woman.

Give to our children, our growing girls, and our young women occupation which, according to their age and capacity, shall develop every faculty of the mind and afford genuine scope for usefulness, and we shall find that the energy which might have been dissipated in unproductive emotions, has been diverted into channels of effective work, and conserved for high and healthful ends.

The most recent measurements of skeletons indicate that the ancients were not superior to the moderns in stature, but may have been inferior. The average heights of two lots of Romano-British skeletons ranged from four feet ten inches for women to five feet two inches for the larger men; and the average height of twenty-five mummies in the British Museum is fifty-five inches for females and sixty-one inches for males.

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF WINTER.

By GARRETT P. SERVISS.

I HAVE never beheld the first indications of the rising of Orion without a peculiar feeling of awakened expectation, like that of one who sees the curtain rise upon a drama of absorbing interest. And certainly the magnificent company of the winter constellations, of which Orion is the chief, make their entrance upon the scene in a manner that may be almost described as dramatic. First in the east come the world-renowned Pleiades. At about the same time Capella, one of the most beautiful of stars, is seen flashing above the northeastern horizon. These are the sparkling ushers to the coming spectacle. In an hour the fiery gleam of Aldebaran appears at the edge of the dome below the Pleiades, a star noticeable among a thousand for its color alone, besides being one of the brightest of the heavenly host. The observer familiar with the constellations knows, when he sees this red star which marks the eye of the angry bull, Taurus, that just behind the horizon stands Orion with starry shield and upraised club to meet the charge of his gigantic enemy. With Aldebaran rises the beautiful V-shaped group of the Hyades. Presently the star-streams of Eridanus begin to appear in the east and southeast, the immediate precursors of the rising of Orion :

> " And now the river-flood's first winding reach
> The becalmed mariner may see in heaven,
> As he watches for Orion to espy if he hath aught to say
> Of the night's measure or the slumbering winds."

The first glimpse we get of the hero of the sky is the long bending row of little stars that glitter in the lion's skin which, according to mythology, serves him for a shield. The great constellation then advances majestically into sight. First of its principal stars appears Bellatrix in the left shoulder ; then the little group forming the head, followed closely by the splendid Betelgeuse, " the martial star," flashing like a decoration upon the hero's right shoulder. Then come into view the equally beautiful Rigel in the left foot, and the striking row of three bright stars forming the Belt. Below these hangs another starry pendant marking the famous sword of Orion, and last of all appears Saiph in the right knee. There is no other constellation containing so many bright stars. It has two of the first magnitude, Betelgeuse and Rigel ; the three stars in the Belt, and Bellatrix in the left shoulder, are all of the second magnitude ; and besides these Orion contains three stars of the third magnitude, and more than a dozen of the fourth, besides innumerable twinklers of smaller magnitudes, whose commingled scintillations form a celestial illumination of singular splendor.

"Thus graced and armed he leads the starry host."

By the time Orion has chased the Bull half-way up the eastern slope of the firmament, the peerless Dog-Star, Sirius, is flaming at the edge of the horizon, while farther north glitters Procyon, the Little Dog-Star, and still higher are seen the twin stars in Gemini. When these constellations have advanced well toward the meridian, as shown in our circular Map No. 1, their united radiance forms a scene never to be forgotten. Counting one of the stars in Gemini as of the first rank, there are no less than seven first-magnitude stars ranged around one another in a way that can not fail to attract the attention and the admiration of the most careless observer. Aldebaran, Capella, the Twins, Procyon, Sirius, and Rigel mark the angles of a huge hexagon, while Betelgeuse shines with ruddy beauty not far from the center of the figure. The heavens contain no other naked-eye view comparable with this great array, not even the glorious celestial region where the Southern Cross shines supreme, being equal to it in splendor.

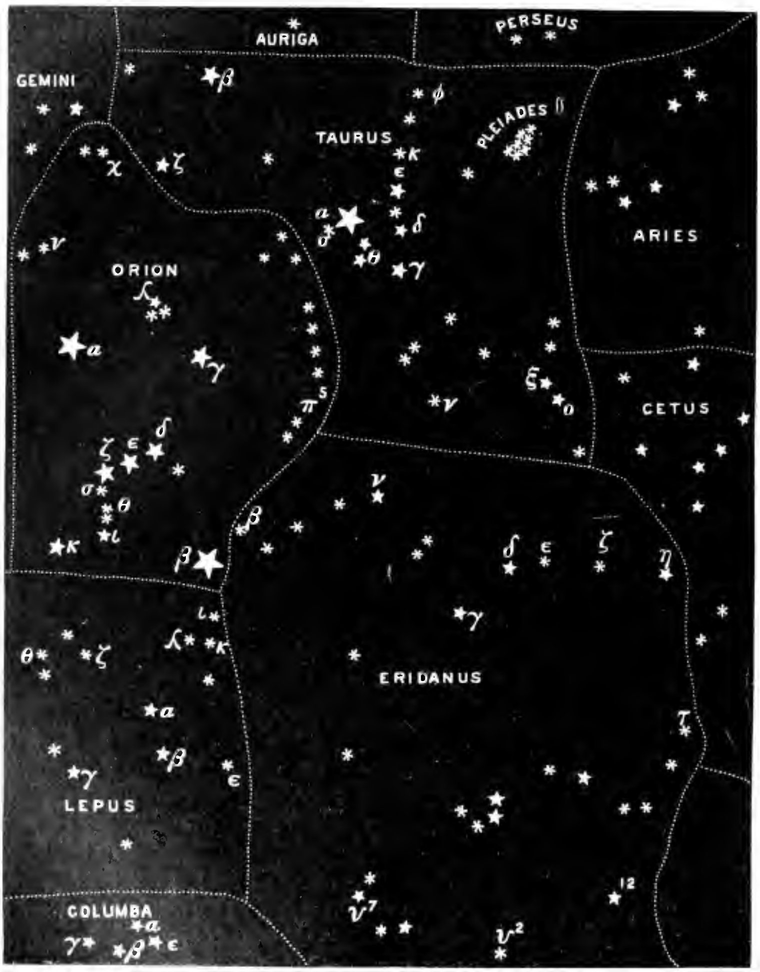
To counterbalance the discomforts of winter observations of the stars, the observer finds that the softer skies of summer have no such marvellous brilliants to dazzle his eyes as those that illumine the hyemal heavens. To comprehend the real glories of the celestial sphere in the depth of winter one should spend a few clear nights in the rural districts of New York or New England, when the hills, clad with sparkling blankets of crusted snow, reflect the glitter of the living sky. In the pure frosty air the stars seem splintered and multiplied indefinitely, and the brighter ones shine with a splendor of light and color unknown to the denizen of the smoky city, whose eyes are dulled and blinded by the glare of street-lights. There one may detect the delicate shade of green that lurks in the imperial blaze of Sirius, the beautiful rose-red light of Aldebaran, the rich orange hue of Betelgeuse, the blue-white radiance of Rigel, and the pearly luster of Capella. If you have never seen the starry heavens except as they appear from city streets and squares, then, I had almost said, you have never seen them at all, and especially in the winter is this true. I wish I could describe to you the impression that they can make upon the opening mind of a country boy, who, knowing as yet nothing of the little great world around him, stands in the yawning silence of night and beholds the illimitably great world above him, looking deeper than thought can go into the shining vistas of the universe, and overwhelmed with the wonder of those marshaled suns.

Looking, now, at Map No. 1, we see the heavens as they appear at midnight on the 1st of December, at 10 o'clock P. M. on the 1st of January, and at 8 o'clock P. M. on the 1st of February. In the western half of the sky we recognize Andromeda, Pegasus, Pisces, Cetus, Aries, Cassiopeia, and other constellations that we studied in the "Stars of Autumn." Far over in the east we see rising Leo, Cancer, and Hydra, which we included among the "Stars of Spring." Occupying most of the southern and eastern heavens are the constellations which we are

MAP 1.

now to describe under the name of the "Stars of Winter," because in that season they are seen under the most favorable circumstances. I have already referred to the striking manner in which the principal stars of some of these constellations are ranged round one another. By the aid of the map the observer can perceive the relative position of the different constellations, and having fixed this in his mind, he will be prepared to study them in detail.

Let us begin now with Map No. 2, which shows us the constellations of Eridanus, Lepus, Orion, and Taurus. Eridanus is a large though not very conspicuous constellation, which is generally supposed to represent the celebrated river now known as the Po. It has had different names among different peoples, but the idea of a river, suggested by its long, winding streams of stars, has always been preserved. According to fable, it is the river into which Phaeton fell after his disastrous attempt to drive the chariot of the sun for his father Phœbus, and in which hare-brained adventure he narrowly missed burning the



Map 2.

world up. The imaginary river starts from the brilliant star Rigel, in the left foot of Orion, and flows in a broad upward bend toward the west; then it turns in a southerly direction until it reaches the bright star Gamma (γ), where it bends sharply to the north, and then quickly sweeps off to the west once more, until it meets the group of stars marking the head of Cetus. Thence it runs south, gradually turning eastward, and finally flowing back more than half-way to Orion, and then curving south again and disappearing beneath the horizon. Throughout this whole distance of more than 100° the course of the stream is marked by rows of stars, and can be recognized without difficulty by the amateur observer.

The first thing to do with your opera-glass, after you have fixed the general outlines of the constellation in your mind by naked eye observations, is to sweep slowly over the whole course of the stream, beginning at Rigel, and following its various wanderings. Eridanus ends in the southern hemisphere near a first-magnitude star called Achernar, which is situated in the stream, but can not be seen from our latitudes. Along the stream you will find many interesting groupings of the stars. In the map see the pair of stars below and to the right of Nu (ν). These are the two Omicrons, the upper one being o^1 and the lower one o^2. The latter is of an orange hue, and is remarkable for the speed with which it is flying through space. There are only one or two stars whose proper motion, as it is called, is more rapid than that of o^2 in Eridanus. It changes its place nearly seven minutes of arc in a century. The records of the earliest observations we possess show that near the beginning of the Christian era it was about half-way between o^1 and ν. Its companion, o^1, on the contrary, seems to be almost stationary, so that o^2 will gradually draw away from it, passing on toward the southwest until, in the course of centuries, it will become invisible from our latitudes. This flying star is accompanied by two minute companions, which in themselves form a close and very delicate double star. These two little stars, of only 9·5 and 10·5 magnitude, respectively, are, of course, beyond the ken of the observer with an opera-glass. The system of which they form a part, however, is intensely interesting, since the appearances indicate that they belong, in the manner of satellites, to o^2, and are fellow-voyagers of that wonderful star.

Having admired the star-groups of Eridanus, one of the prettiest of which is to be seen around Beta (β), let us turn next to Taurus, just above or north of Eridanus. Two remarkable clusters at once attract the eye, the Hyades, which are shaped somewhat like the letter V, with Aldebaran in the upper end of the left-hand branch, and the Pleiades, whose silvery glittering has made them celebrated in all ages. The Pleiades are in the shoulder and the Hyades in the face of Taurus, Aldebaran most appropriately representing one of his blazing eyes as he hurls himself against Orion. The constellation makers did not trouble themselves to make a complete Bull, and only the head and fore-quarters of the animal are represented. If Taurus had been completed on the scale on which he was begun there would have been no room in the sky for Aries; one of the Fishes would have had to abandon his celestial swimming-place, and even the fair Andromeda would have found herself uncomfortably situated. But as if to make amends for neglecting to furnish their heavenly Bull with hind-quarters, the ancients gave him a most prodigious and beautiful pair of horns, which make the beholder feel alarmed for the safety of Orion. Starting out of the head above the Hyades, as illustrated in our cut, the horns curve upward and to the east, each being tipped by a bright star. Along and between the horns runs a scattered and

THE "GOLDEN HORNS" OF TAURUS.

broken stream of minute stars which seem to be gathered into knots just beyond the end of the horns, where they dip into the edge of the Milky-Way. Many of these stars can be seen, on a dark night, with an ordinary opera-glass, but to see them well, one should use as large a field-glass as he can obtain. With such a glass their appearance almost makes one suspect that Virgil had a poetic prevision of the wonders yet to be revealed by the telescope when he wrote, as rendered by Dryden, of the season—

> "When with his *golden horns* in full career
> The Bull beats down the barriers of the year."

Below the tips of the horns, and over Orion's head, there is also a rich clustering of stars, as if the Bull were flaunting shreds of sparkling raiment torn from some celestial victim of his fury. With an ordinary glass, however, the observer will not find this star-sprinkled region around the horns of Taurus as brilliant a spectacle as that presented by the Hyades and the group of stars just above them in the Bull's ear. The two stars in the tips of the horns are both interesting, each in a different way. The upper and brighter one of the two marked Beta (β) in Map No. 2, is called El Nath. It is common to the left horn of Taurus and the right foot of Auriga, who is represented standing just above. It is a singularly white star. This quality of its light becomes conspicuous when it is looked at with a glass. The most inexperienced observer will hardly fail to be impressed by the pure whiteness of El Nath, in comparison with which he will find that many of the stars he had supposed to be white show a decided tinge of color. The star in the tip of the right, or southern horn, Zeta (ζ), is remarkable, not on its own account, but because it serves as a pointer to a famous nebula, the discovery of which led Messier to form his catalogue of nebulæ. This is sometimes called the "Crab Nebula," from the long sprays of nebulous matter which were seen surrounding it with Lord Rosse's great telescope. Our little sketch is simply intended to enable the observer to locate this strange object. If he wishes to study its appearance, he must use a powerful telescope. But with a first-rate field-glass he can see it as a speck of light in the position shown in the cut, where the large star is Zeta and the smaller ones are faint stars, the relative position of which will enable the observer to find the nebula, if he keeps in mind that the top of the cut is toward the north. It is noteworthy that this nebula for a time deceived several of the watchers who were on the lookout for the predicted return of Halley's comet in 1835.

THE CRAB NEBULA.

And now let us look at the Hyades, an assemblage of stars not less beautiful than their more celebrated sisters the Pleiades. The leader of the Hyades is Aldebaran, or Alpha Tauri, and his followers are worthy of their leader. The inexperienced observer is certain to be surprised by the display of stars which an opera-glass brings to view in the Hyades. Our illustration will give some notion of their appearance with a large field-glass. The "brackish poet," of whose rhymes Admiral Smyth was so fond, thus describes the Hyades :

"In lustrous dignity aloft see Alpha Tauri shine,
The splendid zone he decorates attests the Power divine:
For mark around what glitt'ring orbs attract the wandering eye,
You'll soon confess no other star has such attendants nigh."

The redness of the light of Aldebaran is a very interesting phenomenon. Careful observation detects a decided difference between its color and that of Betelgeuse, or Alpha Orionis, which is also a red star. It differs, too, from the brilliant red star of summer, Antares. Aldebaran has a trace of rose color in its light, while Betelgeuse is of a very deep orange, and Antares may be described as fire-red. These shades of color can easily be detected by the naked eye after a little practice. First compare Aldebaran and Betelgeuse, and glance from each to the brilliant white, or bluish-white, star Rigel in Orion's foot.

Upon turning the eye back from Rigel to Aldebaran the peculiar color of the latter is readily perceived. Spectroscopic analysis has revealed the presence in Aldebaran of hydrogen, sodium, magnesium, calcium, iron, bismuth, tellurium, antimony, and mercury. And so modern discoveries, while they have pushed back the stars to distances of which the ancients could not conceive, have, at the same time, and equally, widened the boundaries of the physical universe and abolished forever the ancient distinction between the heavens and the earth. It is a plain road from the earth to the stars, though mortal feet can not tread it.

Keeping in mind that in our little picture of the Hyades the top is north, the right hand west, and left hand east, the reader will be able to identify the principal stars in the group. Aldebaran is readily recognized, because it is the largest of all. The bright star near the upper edge of the picture is Epsilon Tauri, and its sister star, forming the point of the V, is Gamma Tauri. The three brightest stars between Epsilon and Gamma, forming a little group, are the Deltas, while the pair of stars surrounded by many smaller ones, halfway between Aldebaran and Gamma, are the Thetas. These stars present a very pretty appearance, viewed with a good glass, the effect being heightened by a contrast of color in the two Thetas. The little pair southeast of Aldebaran, called the Sigmas, is also a beautiful object. The distance apart of these stars is about seven minutes of arc, while the distance between the two Thetas is about five and a half minutes of arc. These measures may be useful to the reader in estimating the distances between other stars that he may observe. It will also be found an interesting test of the eye-sight to endeavor to see these stars as doubles with the unaided eye. Persons having keen eyes will be able to do this.

THE HYADES.

North of the star Epsilon will be seen a little group in the ear of the Bull (see cut, "The Golden Horns of Taurus"), which presents a brilliant appearance with a small glass. The southernmost pair in the group are the Kappas, whose distance apart is very nearly the same as that of the Thetas, described above; but I think it improbable that anybody could separate them with the naked eye, as there is a full magnitude between them in brightness, and the smaller star is only of magnitude 6·5, while sixth-magnitude stars are generally reckoned as the smallest that can be seen by the naked eye. Above the Kappas, and in the same group in the ear, are the two Upsilons, forming a wider pair.

Next we come to the Pleiades.

"Though small their size and pale their light, wide is their fame."

In every age and in every country the Pleiades have been watched, admired, and wondered at, for they are visible from every inhabited land on the globe. To many they are popularly known as the Seven Stars, although few persons can see more than six stars in the group with the unaided eye. It is a singular fact that many of the earliest writers declare that only six Pleiades can be seen, although they all assert that they are seven in number. These seven were the fabled daughters of Atlas, or the Atlantides, whose names were Merope, Alcyone, Celæno, Electra, Taygeta, Asterope, and Maia. One of the stories connected with them is that Merope married a mortal, whereupon her star grew dim among her sisters. Another fable assures us that Electra, unable to endure the sight of the burning of Troy, hid her face in her hands, and so blotted her star from the sky. While we may smile at these stories, we can not entirely disregard them, for they are intermingled with some of the richest literary treasures of the world, and they come to us, like some old keepsake, fragrant with the perfume of a past age. The mythological history of the Pleiades is intensely interesting, too, because it is world wide. They have impressed their mark, in one way or another, upon the habits, customs, traditions, language, and history of probably every nation. This is true of savage tribes as well as of great empires. The Pleiades furnish one of the principal links that appear to connect the beginnings of human history with that wonderful prehistoric past, where, as through a gulf of mist, we seem to perceive faintly the glow of a golden age beyond. The connection of the Pleiades with traditions of the Flood is most remarkable. In almost every part of the world, and in various ages, the celebration of a feast or festival of the dead, dimly connected by tradition with some great calamity to the human race in the past, has been found to be directly related to the Pleiades. This festival or rite, which has been discovered in various forms among the ancient Hindoos, Egyptians, Persians, Peruvians, Mexicans, Druids, etc., occurs always in the month of November, and is regulated by the culmination of the Pleiades. The Egyptians directly connected this celebration with a deluge, and the Mexicans, at the time of the Spanish conquest, had a tradition that the world had once been destroyed at the time of the midnight culmination of the Pleiades. Among the savages inhabiting Australia and the Pacific island groups a similar rite has been discovered. It has also been suggested that the Japanese feast of lanterns is not improbably related to this world-wide observance of the Pleiades, as commemorating some calamitous event in the far past which involved the whole race of man in its effects.

The Pleiades.

The Pleiades also have a supposed connection with that mystery of mysteries, the great Pyramid of Cheops. It has been found that about the year 2170 B. C., when the beginning of spring coincided with the culmination of the Pleiades at midnight, that wonderful group of stars was visible, just at midnight, through the mysterious southward-pointing passage of the Pyramid. At the same date the then pole-star, Alpha Draconis, was visible through the northward-pointing passage of the Pyramid.

Another curious myth involving the Pleiades as a part of the constellation Taurus is that which represents this constellation as the Bull into which Jupiter changed himself when he carried the fair Europa away from Phœnicia to the continent that now bears her name. In this story the fact that only the head and fore-quarters of the Bull are visible in the sky is accounted for on the ground that the remainder of his body is beneath the water through which he is swimming. Here, then, is another apparent link with the legends of the Flood, with which the Pleiades have been so strangely connected, as by common consent among so many nations, and in the most widely-separated parts of the earth.

With the most powerful field-glass you may be able to see all of the stars represented in our picture of the Pleiades. With an ordinary opera-glass the fainter ones will not be visible; yet even with such a glass the scene is a remarkable one. Not only all of the "Seven Sisters," but many other stars can be seen twinkling among them. The superiority of Alcyone to the others, which is not so clear to the naked eye, becomes very apparent. Alcyone is the large star below the middle of the picture with a triangle of little stars beside it. To the left or east of Alcyone the two most conspicuous stars are Atlas and Pleione. The latter—which is the uppermost one—is represented too large in the picture. It requires a sharp eye to see Pleione without a glass, while Atlas is plainly visible to the unaided vision, and is always counted among the naked-eye Pleiades, although it does not bear the name of one of the mythological sisters, but that of their father. The bright star below and to the right of Alcyone is Merope; the one near the right-hand edge of the picture, about on a level with Alcyone, is Electra. Above, or to the north of Electra, are two bright stars lying in a line pointing toward Alcyone; the upper one of these, or the one farthest from Alcyone, is Taygeta, and the other is Maia. Above Taygeta and Maia, and forming a little triangle with them, is a pair of stars which bears the name of Asterope. About half-way between Taygeta and Electra, and directly above the latter is Celæno.

The naked-eye observer will probably find it difficult to decide which he can detect the more easily, Celæno or Pleione, while he will discover that Asterope, although composed of two stars, as seen with a glass, is so faint as to be much more difficult than either Celæno or Pleione. Unless, as is not improbable, the names have become interchanged in the course of centuries, the brightness of these stars would seem to have undergone remarkable changes. The star of Merope, it will be remembered, was fabled to have become faint, or disappeared, because she married a mortal. At present Merope is one of those that can be plainly seen with the naked eye, while the star of Asterope, who was said to have had the god Mars for her spouse, has faded away until only a glass can show it. It would appear, then, that notwithstanding an occasional temporary eclipse, it is, in the long run, better to marry a plain mortal than a god—or a lord. Electra, too, who hid her fair eyes at the sight of burning Troy, seems to have recovered from her fright, and at present is, next to Alcyone, the brightest star in the cluster. But however we may regard those changes in the brightness of the Pleiades which are based upon tradition, there is no doubt that well-attested changes have taken place in the comparative brilliancy of stars in this cluster since astronomy has become an exact science.

Observations of the proper motions of the Pleiades have shown that there is an actual physical connection between them; that they are, literally speaking, a flight of suns. Their common motion is toward the southwest under the impulse of forces that remain as yet beyond the grasp of human knowledge. Alcyone was selected by Mädler as the central sun around which the whole starry system revolved, but later investigations have shown that his speculation was not well founded, and that, so far as we can determine, the proper motions of the stars are not such as to indicate the existence of any common center. They appear to be flying with different velocities in every direction, although—as in the case of the Pleiades—we often find groups of them associated together in a common direction of flight.

Still another curious fact about the Pleiades, is the existence of some rather mysterious nebulous masses in the cluster. In 1859, Temple discovered an extensive nebula, of an oval form, nearly egg-shaped, with the star Merope immersed in one end of it. Subsequent observations showed that this strange phenomenon was variable. Sometimes it could not be seen; at other times it was very plain and large. In Jeaurat's chart of the Pleiades, made in 1779, a vast nebulous mass is represented near the stars Atlas and Pleione. This has since been identified by Goldschmidt as part of a huge, ill-defined nebula, which he thought he could perceive enveloping the whole group of the Pleiades. Many observers, however, could never see these nebulous masses, and were inclined to doubt their actual existence. Within the past few years astronomical photography, having made astonishing progress, has thrown new light upon this mysterious subject. The sensitized plate of the camera, when applied at the focus of a properly-constructed telescope, has proved more effective than the human retina, and has, so to speak, enabled us to see beyond the reach of vision by means of the pictures it makes of objects which escape the eye. In November, 1885, Paul and Prosper Henry turned their great photographing telescope upon the Pleiades, and with it discovered a nebula apparently attached to the star Maia. The most powerful telescopes in the world had never revealed this to the eye. Yet of its actual existence there can be no question. Their photograph also showed the Merope nebula, although much smaller, and of a different form from that represented by its discoverer and others. There evidently yet remains much to be discovered in this singular group, and the mingling of nebulous matter with its stars makes Tennyson's picturesque description of the Pleiades appear all the more life-like:

> "Many a night I saw the Pleiads, rising through the mellow shade
> Glitter like *a swarm of fire-flies tangled in a silver braid*."

The reader should not expect to be able to see the nebulæ in the Pleiades with an opera-glass. I have thought it proper to mention these nebulous objects only in order that he might be in possession of the principal and most curious facts about those interesting stars.

Orion will next command our attention. You will find the constellation in Map No. 2.

> "Eastward beyond the region of the Bull
> Stands great Orion; whoso kens not him in cloudless night
> Gleaming aloft, shall cast his eyes in vain
> To find a brighter sign in all the heaven."

To the naked eye, to the opera-glass, and to the telescope, Orion is alike a mine of wonders. This great constellation embraces almost every variety of interesting phenomena that the heavens contain. Here we have the grandest of the nebulæ, some of the largest and most beautifully-colored stars, star-streams, star-clusters, nebulous stars, variable stars. I have already mentioned the positions of the principal stars in the imaginary figure of the great hunter. I may add that his upraised right arm and club are represented by the stars seen in the map above Alpha (α) or Betelgeuse, one of which is marked Nu (ν) and another, in the knob of the club, Chi (χ). I have also, in speaking of Aldebaran, described the contrast in the colors of Betelgeuse and Beta (β) or Rigel. Betelgeuse, it may be remarked, is slightly variable. Sometimes it appears brighter than Rigel, and sometimes less brilliant. It is interesting to note that according to Secchi's division of the stars into types, based upon their spectra, Betelgeuse falls into the third order, which seems to represent a type of suns in which the process of cooling, and the formation of an absorptive envelope or shell have gone on so far that we may regard them as approaching the point of extinction. Rigel, on the other hand, belongs to the first order or type which represents suns that are probably both hotter and younger in the order of development. So, then, we may look upon the two chief stars of this great constellation as representing two stages of cosmical existence. Betelgeuse shows us a sun that has almost run its course, that has passed into its decline, and that already begins to faint and flicker and grow dim before the on-coming and inevitable fate of extinction ; but in Rigel we see a sun blazing with the fires of youth, splendid in the first glow of its solar energies, and holding the promise of the future yet before it. Rigel belongs to a new generation of the universe ; Betelgeuse to the universe that is passing. We may pursue this comparison one step farther back and see in the great nebula, which glows dimly in the middle of the constellation, between Rigel triumphant and Betelgeuse languishing, a still earlier cosmical condition—the germ of suns whose infant rays may illuminate space when Rigel itself is growing dim.

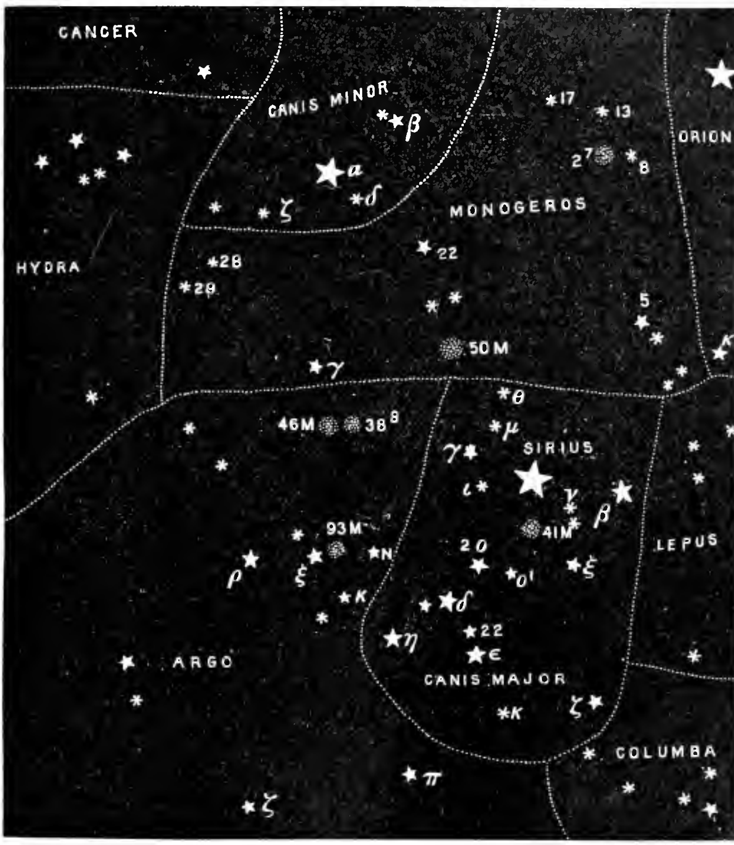

THE SWORD OF ORION AND THE GREAT NEBULA.

Turn your glass upon the three stars forming the Belt. You will not be likely to undertake to count all the twinkling lights that you will see, especially as many of them appear and disappear as you turn your attention to different parts of the field. Sweep all around the Belt and also between the Belt and Gamma (γ) or Bellatrix. According to the old astrologers, women born under the influence of the star Bellatrix were lucky, and provided with good tongues. Of course this was fortunate for their husbands.

Below the belt will be seen a short row of stars hanging downward and representing the sword. In the middle of this row is the great Orion nebula. The star Theta (θ) involved in the nebula is multiple and the position of this little cluster of suns is such that, as has been said, they seem to be feeding upon the substance of the nebula surrounding them. Other stars are seen scattered in different parts of the nebula. This phenomenon can be plainly seen with an opera-glass. Our picture of the Sword of Orion shows its appearance with a good field-glass. With such a glass several fine test-objects will be found in the Sword. One of the best of these is formed by the two five-pointed stars seen in the picture close together above the nebula. No difficulty will be encountered in separating these stars with a field-glass, but it will require a little sharp watching to detect the small star between the two and just above the line joining them. So, the bending row of faint stars above and to the right of the group just described will be found rather elusive as individuals, though easily glimpsed as a whole. Of the great nebula itself not much detail can be seen. Yet by averting the eyes the extension of the nebulous light in every direction from the center can be detected and traced, under favorable circumstances, to a considerable distance. The changes that this nebula has certainly undergone in the brilliancy, if not in the form, of different parts of it, are perhaps indications of the operation of forces, which we know must prevail there, and whose tendency can only be in the direction of condensation, and the ultimate formation of future suns and worlds. Yet, as the appearance of the nebula in great telescopes shows, we can not expect that the processes of creation will here produce a homologue of our solar system. The curdled appearance of the nebula indicates the formation of various centers of condensation the final result of which will doubtless be a group of stars like some of those which we see in the heavens, and whose common motion shows that they are bound together in the chains of reciprocal gravitation. The Pleiades are an example of such a group.

Do not fail to look for a little star just west of Rigel, and which, with a good opera-glass, appears to be almost hidden in the flashing rays of its brilliant companion. If you have also a field-glass, after you have detected this shy little twinkler with your opera-glass, try the larger glass upon it. You will find then that the little star originally seen is not the only one there. A still smaller star, which had before been completely hidden, will now be perceived. I may add that, with telescopes, Rigel is one of the most beautiful double stars in the sky, having a little blue companion close under its wing. Run your glass along the line of little stars forming the lion's skin or shield that Orion opposes to the onset of Taurus. Here you will find some interesting combinations, and the star marked on the map π^5 will especially attract your eye, because it is accompanied, about fifteen minutes to the northwest, by a seventh-magnitude star of a remarkably rich orange hue.

Look next at the little group of three stars forming the head of Orion. Although there is no nebula here, yet these stars, as seen with the naked eye, have a remarkably nebulous look, and Ptolemy regarded the group as a nebulous star. The largest star is called Lambda (λ); the others are Phi (φ) one and two. An opera-glass will show another star above λ, and a fifth star below ϕ^2, which is the farthest of the two Phis from Lambda. It will also reveal a faint twinkling between λ and ϕ^1. A field-glass shows that this twinkling is produced by a pretty little row of three stars of the eighth and ninth magnitudes.



MAP 3.

In fact, Orion is such a striking object in the sky that more than one attempt has been made to steal away its name and substitute that of some modern hero. The University of Leipsic, in 1807, formally resolved that the stars forming the Belt and Sword of Orion should henceforth be known as the constellation of Napoleon. A more ridiculous proposition was that of an Englishman, who proposed to rename Orion for the British naval bull-dog Nelson.

The little constellations of Lepus and Columba, below Orion, need not detain us long. You will find in them some pretty combinations of stars. In Lepus is the celebrated "Crimson Star," which has been described as resembling a drop of blood in color—a truly marvelous hue for a sun—but, as it is never brighter than the sixth magnitude, and from that varies down to the ninth, we could hardly hope to see its color well with an opera-glass. Besides, the observer would have difficulty in finding it.

We will now turn to the constellation of Canis Major, represented in Map No. 3. Although, as a constellation, it is not to be compared with the brilliant Orion, yet, on account of the unrivaled magnificence of its chief star, Canis Major presents almost as attractive a scene as its more extensive rival. Everybody has heard of Sirius, or the Dog-Star, and everybody must have seen it flashing and scintillating so splendidly in the winter heavens, that to call it a first-magnitude star does it injustice, since no other star of that magnitude is at all comparable with it. Sirius, in fact, stands in a class by itself as the brightest star in the sky. Its light is white with a shade of green which requires close watching to be detected. When it is near the horizon, or when the atmosphere is very unsteady, Sirius flashes prismatic colors like a great diamond. The question has been much discussed as to whether Sirius was not formerly a red star. It is described as red by several ancient authors, but it seems to be pretty well established that these descriptions are most of them due to a blunder made by Cicero in his translation of the astronomical poem of Aratus. It is not impossible, though it is highly improbable, that Sirius has changed color.

Delta Orionis and its Neighbors.

Your eyes will be fairly dazzled when you turn your glass upon this splendid star. By close attention you will be able to perceive a number of faint stars, mere points by comparison, in the immediate neighborhood of Sirius. There are many interesting objects in the constellation. The star marked Nu (ν) in the map, is really triple, as the smallest glass will show. Look next at the star-group 41 M. The cloud of minute stars of which it is composed can be very well seen with a field-glass or a powerful opera-glass. The star 22 is of a very ruddy color that contrasts beautifully with the light of Epsilon (ϵ), which can be seen in the same field of view with an opera-glass.

Between the stars Delta (δ) and o^1 and o^2 there is a remarkable array of minute stars, as shown in the accompanying cut. One never sees stars arranged in streams or rows, like these, without an irresistible impression that the arrangement can not be accidental; that some law must have been in operation which associated them together in the forms which we see. Yet, when we reflect that these are all suns, how far do we seem to be from understanding the meaning of the universe.

The extraordinary size and brilliancy of Sirius might naturally enough lead one to suppose that it is the nearest of the stars, and such it was once believed to be. Observations of stellar parallax, however, show that this was a mistake. The distance of Sirius is so great that no satisfactory determination of it has yet been made. We may safely say, though, that that distance is, at the least calculation, 50,000,000,000,000 miles. In other words, Sirius is about 537,000 times as far from the earth as the sun is. Then since light diminishes as the square of the distance increases, the sun, if placed as far from us as Sirius is, would send us, in round numbers, 288,000,000,000 times less light than we now receive from it. But Sirius actually sends us only about 4,000,000,000 times less light than the sun does; consequently Sirius must shine $\frac{288,000,000,000}{4,000,000,000} = 72$ times as brilliantly as the sun. If we adopt Wollaston's estimate of the light of Sirius, as compared with that of the sun's, viz., $\frac{1}{20,000,000,000}$, we shall still find that the actual brilliancy of that grand star is more than fourteen times as great as that of our sun. But as observations on the companion of Sirius show that Sirius's mass is fully twenty times the sun's, and since the character of Sirius's spectrum indicates that its intrinsic brightness, surface for surface, is much superior to the sun's, it is probable that our estimate of the star's actual brilliancy, as compared with what the sun would possess at the same distance, viz., seventy-two times, is much nearer the truth. It is evident that life would be insupportable upon the earth if it were placed as near to Sirius as it is to the sun. If the earth were a planet belonging to the system of Sirius, in order to enjoy the same amount of heat and light it now receives, it would have to be removed to a distance of nearly 800,000,000 miles, or about 8½ times its distance from the sun. Its time of revolution around Sirius would then be nearly 5½ years, or, in other words, the year would be lengthened 5½ times.

But, as I have said, the estimate of Sirius's distance used in these calculations is the smallest that can be accepted. Good authorities regard the distance as being not less than 100,000,000,000,000 miles; in which case the star's brilliancy must be as much as 228 times greater than that of the sun! And yet even Sirius is probably not the greatest sun belonging to the visible universe. There can be little doubt that Canopus, in the southern hemisphere, is a grander sun than Sirius.

To our eyes, Canopus is only about half as bright as Sirius, and it ranks as the second star in the heavens in the order of brightness. But while Sirius's distance is measurable, that of Canopus is so unthinkably immense that astronomers can get no grip upon it. If it were only twice as remote as Sirius it would be equal to two of the latter, but the probability is its distance is much greater than that. And possibly even Canopus is not the greatest gem in the coronet of creation.

East and south of Canis Major, which, by the way, is fabled to represent one of Orion's hounds, is part of the constellation Argo, which stands for the ship in which Jason sailed in search of the golden fleece. The observer will find many objects of interest here, although some of them are so close to the horizon in our latitudes that much of their brilliancy is lost. Note the two stars ζ and π near the lower edge of the map, then sweep slowly over the space lying between them. About half-way your attention will be arrested by a remarkable arrangement of stars, in which a beautiful half-circle of small stars curving above a larger one, which is reddish in color, is conspicuous. This neighborhood will be found rich in stars that the naked eye can not see. Just below the star η in Canis Majoris is another fine group. The star π, which is deep yellow or orange, has three little stars above it, two of which form a pretty pair. The star ξ has a companion, which forms a fine test for an opera-glass, and is well worth looking for. Look also at the cluster 93 M, just above and to the west of ξ. The stars η and κ are seen double with an opera-glass.

The two neighboring clusters, 46 M and 38^8, are very interesting objects. To see them well, use a powerful field-glass. A "fiery fifth-magnitude star," as Webb calls it, can be seen in the field at the same time. The presence of the Milky-Way is manifest by the sprinkling of stars all about this region.

Turning now to the constellation Monoceros, we shall find a few objects worthy of attention. This constellation is of comparatively modern origin, having been formed by Bartschius, whose chief title to distinction is that he married the daughter of John Kepler. The region around the stars 8, 13, and 17 will be found particularly rich, and the cluster 2^7 shows well with a strong glass. Look also at the cluster 50 M, and compare its appearance with that of the clusters in Argo.

With these constellations we finish our review of the celestial wonders that lie within the reach of so humble an instrument as an opera- or field-glass. We have made the circuit of the sky, and the hosts that illumine the vernal heavens are now seen advancing from the east, and pressing close upon the brighter squadrons of winter. Their familiar figures resemble the faces of old friends whom we are glad to welcome. These starry acquaintances never grow wearisome. Their interest for us is as fathomless as the deeps of space in which they shine. The man never yet lived whose mind could comprehend the full meaning of the wondrous messages that they flash to us upon the wings of light. As we watch them in their courses, the true music of the spheres comes to our listening ears, the chorus of creation—faint with distance, for it is by slow approaches that man draws near to it—chanting the grandest of epics, the Poem of the Universe ; and the theme that runs through it all is the reign of law. Do not be afraid to become a star-gazer. The human mind can find no higher exercise. He who studies the stars will discover—

> "An endless fountain of immortal drink
> Pouring unto us from heaven's brink."

THE ADULTERATION OF MILK.

By Professor C. HANFORD HENDERSON.

THE absolute necessity of maintaining a certain standard of purity in food-products, has led, in most of the States, to a comprehensive and somewhat stringent legislation concerning adulteration. Particularly is this the case as regards the products of the dairy. The official inspection busies itself with both the qualitative and quantitative value of these articles. Of all the foods supplied directly by Nature, milk is the only one which contains all the elements of nutrition in the relative proportions required by man, and in a form easy of digestion ; it is therefore the food best suited to young children and invalids—persons who can ill afford to have their food tampered with in any way. This consideration, together with the universal use of the article, has determined the adoption of a system of public inspection in nearly all of our larger cities. The States of Massachusetts, New York, and Michigan have given particular attention to the honesty of the milkman, and the standards of quality and methods of analysis established by their .public analysts have been generally adopted by chemists all over the country. Yet, in spite of the vigilant eye which is thus constantly watching this department of the farm, pounds of butter weighed according to a system of units not recognized in the arithmetics, milk which contains an abnormal percentage of water, and cream whose composition will not bear investigation, are daily sold in the market-places of both city and country.

But there are, of course, two sides to the question. Not unfrequently the milkman is accused entirely without cause. There are few housekeepers who do not sincerely believe, in spite of an otherwise general faith in mankind, that he, at least, will bear watching. The analyst, however, is a perfectly unprejudiced person. He cares little for the protestations of the vender, or the suspicions of the customer. He simply says, "Your milk should have such and such a specific gravity ; it should contain such and such percentages of fat, of other hydrocarbons, of mineral salts, and of water : if it contain these, it is an honest milk; if it do not, it is adulterated." And generally, the analyst is not open to argument. He has implicit faith in his hydrometer and analytical balance.

It is the purpose of the present article to point out the adulterants which are commonly found in milk, and to describe a simple method of analysis which will give conclusive results even when practiced by those having no great proficiency in the use of apparatus and reagents. The complete chemical analysis of a sample of milk is an operation which taxes the patience of even a trained chemist, and when accomplished, it has little value not possessed by the results obtained from the more rapid methods used by the State analysts. It is commonly believed that the list of adulterants at the disposal of the dairyman is practically unlimited, but if one will pause a moment, and reflect that the adulterant chosen must not affect the taste of the milk, or show any tell-tale sediment on standing, he will see that the possibilities of fraud are much smaller than at first suspected. Of all the adulterants, water is the most popular the land over, since it costs nothing and tells no tales unless questioned by an analyst. In addition to water, it is not uncommon to find a milk "doctored" by the use of preservative salts, such as borax or bicarbonate of soda, and colored to an ideal cream tint by means of a little burnt sugar or vegetable coloring-matter.

In the State laboratories, it is generally required that determinations shall be made of the specific gravity, the amount of cream, total solids, fat, mineral salts, and water. Mr. Sharples, public analyst for Massachusetts, recommends also the determination of the amount of sugar in the milk in order to place its quality beyond peradventure. Most analysts, however, do not regard this determination as necessary. As it is our object to make the analytical process as simple as possible, and to bring it within reach of all readers having some delicacy of touch, whether they be chemists or not, we shall only describe those determinations generally considered essential, and then specify which of these will suffice in most cases to establish the quality of the sample under consideration.

The first requisite is to decide upon a standard of purity. Opinions differ as to what should be considered a normal milk. The chief discrepancy lies in the amount of total solids which it should contain. In England the standard in this respect is rather low, only 11·5 per cent of total solids being required. In Massachusetts, on the other hand, the legal standard exceeds even the generosity of Nature, as it calls for 13 per cent, when milk drawn directly from the cow, and therefore free from any possibility of dilution, frequently shows but a little over 12.

The following abbreviated table will give the composition of average milk, and will serve as a standard for comparison when the results of any particular analysis have been obtained:

Specific gravity	1·03
Total solids	12·50
Fat	3·20
Organic solids not fat	8·70
Mineral salts	·60
Water	87·50

The sample of milk selected for examination should be quite fresh, but never warm. The temperature should be about 60° F.

Of the several determinations required, that of specific gravity is at once the easiest and the most important. It is made either by means of the specific-gravity bottle or the hydrometer.

The specific-gravity bottle is a small glass flask which will contain a given weight of distilled water. The form used by the writer is shown in Fig. 1. It is adjusted to fifty grammes of water, and is accompanied by a small brass weight to exactly counterpoise the weight of the flask. To determine the specific gravity of a sample of milk the bottle is completely filled with the milk and the stopper brought into contact with the fluid, care being taken that no air adheres to its under side. The stopper is then permitted to fall quickly into its bearing in the neck of the bottle. The excess of milk escapes through the fine perforation in the stopper. In this way an invariable volume of fluid is always weighed. The flask is then carefully wiped off, and the whole weighed, remembering, of course, to add the counterpoise weight to the scale-pan, in order to allow for the weight of the flask. The weight of the milk is obtained in grammes, and this multiplied by ·02 will give its specific gravity directly.

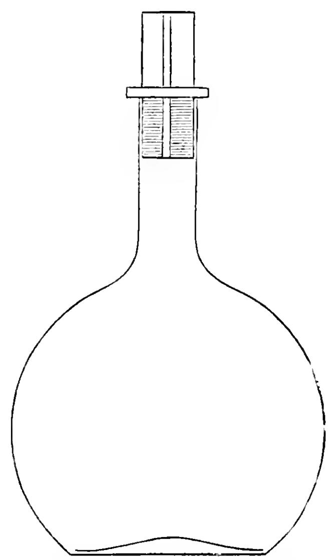


FIG. 1.—FIFTY-GRAMME SPECIFIC-GRAVITY BOTTLE.

By the use of the hydrometer (or lactometer, as it is usually called, when graduated for milk), the determination of the specific gravity may be made much more rapidly. A convenient form of this instrument is shown in Fig. 2. It will require no explanation beyond brief mention of the system of marking employed. The upper graduation on the stem of the tube is marked 1, and is the point to which the instrument will sink when placed in pure, distilled water, at 60° F. The lower graduation is marked 1·05, and is the point to which the instrument will sink when placed in a fluid of that specific gravity. As normal milk averages 1·03, the variations on either side will be fully covered by these limits. A low specific gravity indicates that the pump has been called into requisition, while a high specific gravity indicates a deficiency in cream. A popular form of lactometer, showing directly the proportion of water added to the sample, may be purchased of dealers in chemical apparatus for seventy-five cents, but some care must be exercised in its selection, since one instrument now offered the public has the point marked "skim milk" *above* that marked "pure milk." Evidently it should be *below*, as skimmed milk has a greater specific gravity than whole milk.

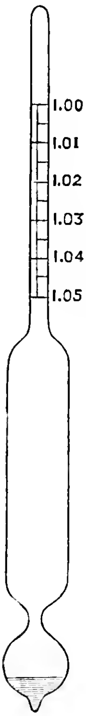


Fig. 2—Lactometer with Direct Graduation.

In some States the test of specific gravity by the lactometer is the only determination made. In spite of the importance of the test, however, it is not always conclusive. A very rich milk will show a suspiciously low specific gravity, while a skimmed milk, diluted with water to the proper density and colored to an agreeable cream-tint by "Richardson's Perfected Butter Color" or other dye, will escape so much as the breath of scandal.

The amount of cream is generally determined by permitting the sample to stand in a graduated jar until the cream separates, and then reading off the volume percentage directly. Centrifugal machines are also used, but a simpler test than either of these is usually sufficient. If a closed tube, blackened on the inside, is dipped into the sample, and slowly withdrawn, one can judge of the richness of the milk by the opacity of the film remaining on the tube.

To determine the total solids, five cubic centimetres of the sample of milk are placed in a small platinum dish of known weight, and the joint weight of milk and dish then obtained. The difference between the two will be the amount of milk taken for analysis. It is then evaporated to dryness on a water-bath without stirring. This will take about an hour, at the end of which time the dish will be found to contain a yellowish-white mass which shows a thin, transparent film on top and a honeycombed structure beneath. A number of cracks will extend throughout the mass, on account of the contraction on drying, but do not indicate that anything is amiss. The dish and contents are then put into an oven at 212° F., and at the end of half an hour are taken out and weighed. The known weight of the dish subtracted from the weight thus obtained gives the weight of the total solids. The ratio of this weight to the weight of milk taken for analysis will give the percentage value.

If it be desired to find the amount of fat, petroleum-benzine is poured over the residue and is renewed at the end of an hour. After standing half an hour longer, the solvent is again decanted. The residue is thoroughly washed with benzine, and is dried in an oven at

212° F., in order to remove all traces of the fluid. The loss of weight experienced as the result of this treatment equals the amount of fat.

The amount of mineral salts is determined by igniting the residue until it is perfectly white. The heat must be very gradually increased in order to avoid loss from sputtering. The ash is then directly weighed, and its percentage value obtained as in the case of the total solids, that is, by the ratio of its weight to the amount of milk originally taken. The water is readily found by subtracting the per cent of total solids from 100.

The operations described above are all very easily made, and require comparatively but a short time. They presuppose, of course, the employment of a certain amount of apparatus, but if one can depend upon the courtesy of some chemical or pharmaceutical friend for the use of an analytical balance, all of the other requirements can be met at no very great expense. An analysis such as has been outlined, will show conclusively the quality of any suspected sample of milk, for the milk will deviate from the normal condition just in proportion as its constituents differ from those of the standard given. If, for instance, it is found that the specific gravity and percentage of total solids are both low, the addition of water is plainly indicated. By calculating the amount of whole milk corresponding to the total solids found, it is possible to state just how much water has been added. When it is found that the specific gravity is as it should be, and the total solids are between 12 and 12·5 per cent, it is seldom worth while to continue the analysis further than a determination of the mineral salts, for it would scarcely be possible for these three quantities to be what they should be unless the milk were quite normal. Thus, in a sample of milk recently analyzed by the writer, the specific gravity was found to be 1·033, the total solids 12·077 per cent, the mineral salts 0·598 per cent, and the water 87·923 per cent. Though the solid constituents were somewhat low, the discrepancy was too slight to fancy for a moment that the milk had been tampered with in any way.

Occasionally chalk or lime-water is added to give body to a diluted milk. Its presence will be readily detected by the increased amount of ash, which may be examined by the well-known qualitative methods. During the warmer months, the difficulties of keeping milk fresh not infrequently lead to the addition of bicarbonate of soda or borax, but as a preservative the latter salt is an absolute failure. It simply keeps the curd from precipitating, but does not prevent the decomposition of the milk. After standing some time such a milk will be found to emit a very putrid, disagreeable odor.

Though the addition of these adulterants is far from commendable on the part of the milkman, the reflection is not without comfort that they exercise for the most part no injurious influence on the animal economy—a reflection, by the way, which can not be indulged in about the majority of food adulterants.

RECENT VIEWS RESPECTING CANCER.

By ROBERT T. MORRIS, M.D.

WHEN one of the gall-flies (*cynips*) stings the tender shoot of a rose-bush, the poison which is deposited along with her eggs excites at that portion of the twig an excessive degree of nutrition, and the resulting swelling becomes the home of the young of the fly.

The rose-bush gall is composed of nothing more than ordinary vegetable tissues; but they are abnormally developed, and there is an accompanying modification in the growth of normal structures. For instance, the vegetable hairs at that point may increase in size until they resemble large thorns, and an involved leaflet may lose its identity and become a part of the tumor. The color-grains (*chlorophyll*), which should give to the bark a green color, may show various shades of red instead. The rose-gall is not very different from the morbid growths of animal tissues which appear as tumors of various kinds; and we know that some, and presume that many, of the latter, are due to the disturbance caused by the presence of humble parasites belonging to the vegetable world. These parasites, or microbes, as they are called, are so small that it is impossible at present to study the life-histories of some of the species. No one has satisfactorily described any specific cancer-producing microbe, but it was only yesterday that we became acquainted with the cousins which cause the development of the tumors of glanders, of tuberculosis, of carbuncle, and of "big-head" (*actinomycosis*)—so that, reasoning by analogy, it seems more than probable that all malignant growths belong to the infectious microbic diseases, and that by to-morrow we shall have the tiny causators in a position in which they can be examined.

The malignant tumors of warm-blooded vertebrate animals are divided into two great classes—the sarcomas and the cancers. These growths are like the galls of various plants, in that they are composed not of new tissues, but of abnormally arranged tissues of ordinary character. Structures in their vicinity lose caste and become merged into tissue of some one type, just as the leaflet gives up its position as a lung for the rose and helps to build a house for the young gall-flies.

We have in cancer a sort of anarchy of cells, as it were, in which the leaders, whose work, for instance, consisted in the construction of muscle, are routed from their high positions and forced to become common members of a low organization.

Like many popular names the term cancer is indefinite, but it is principally used to distinguish three or four forms of malignant growth from the sarcomas and from benign tumors. The benign tumors grow within limiting capsules; pushing other tissues out of the way as they increase in size, and showing no tendency to affect the blood or to appear secondarily at different places in the body of the same patient. The malignant tumors, on the other hand, are those which are not limited by a capsule. They reach out and involve all kinds of tissue which happen to be near them; they infect the blood, and new colonies form at points situated at a distance from the parent growth. There is hardly a doubt but that malignant growths are quite local at the outset, but, like red ants, the microbes make more and more nests in the same field. As with red ants, too, we often fail to eradicate the colony, because many members may be away from home at the time when the nests are destroyed.

Malignant tumors have been produced in the dog by inoculation from an infected dog, in the horse by inoculation from the dog, and the horse has been inoculated from the horse. We are afraid that cancer is inoculable between animals and man, and between man and man, but on this point medical literature at present furnishes little reliable testimony.

Why it is that the cancer microbes which enter a cut on the surgeon's finger do not regularly produce cancer in the surgeon is a fact not easily explained. It is, however, a well-known fact, that certain other species of microbes are very particular about sites for their homes, and we may suppose that the cancer microbe finds a suitable field for growth in a relatively small number of persons.

When a malignant tumor is developing at any one point the lymphatic vessels in the vicinity are involved at an early date, and they eventually serve as channels for the passage of the disease into the blood.

If a far advanced primary growth of cancer could be stained in its entirety with a black dye, and if the patient were transparent, we should probably see that the tissues round about the growth were dusky, and that a thin, smoky coloring extended through the lymphatic vessels to the veins into which they empty. As a malignant tumor increases in size at its original situation the nerve filaments are pinched, and pain is caused as a rule; but sometimes the growth will progress with little or no accompanying pain.

When an operation by a competent surgeon is performed during the early stages of the disease, it may be eradicated completely; and even in cases in which considerable headway has been gained the surgeon is able to give long periods of immunity from the return of the growth. Patients, however, are unfortunately familiar with the traditions of old-time wound treatment, and the dread of an operation is so great that they seldom act in the matter until it is too late to hope for a cure.

The operation for the removal of a malignant growth causes no real suffering when it is done by the surgeons of to-day, who employ anæsthetics for preventing pain during an operation and antiseptics for limiting inflammation afterward. The scientific antiseptic methods of wound treatment deal directly with species of microbes with which naturalists are familiar. According to present beliefs, suppuration and "blood-poisoning"—pyæmia, septicæmia, erysipelas, and lock-jaw—are due to the growth in the wound of microbes which are parasites there; and within the last few years we have learned how to stop the growth of these microbes, and to prevent inflammation after operations with mathematical accuracy. In the application of these methods to the work of removing malignant growths, operators fearlessly expose all infected tissues for great distances, and remove every vestige of the disease in cases in which a few years ago they would not have dared to operate thoroughly for fear of the resulting inflammation.

Treatment by medicines is of no avail in curing malignant growths. The reason why medicines are useless in such cases is evident if we look at the subject through the germ theory, for it can be readily understood that any drug which is powerful enough to destroy cancer microbes would also destroy the blood-corpuscles. It is safe to say, that we shall never have a drug which will cure cancer, in spite of the statements contained in the patent-medicine advertisements. Local applications of caustics for the purpose of curing cancer are seldom made by reputable surgeons to-day, because a glance at the anatomy of a malignant growth is sufficient to show the folly of attempting to reach the deeply-infected lymphatic vessels with anything except the fingers aided by sharp eyes. Very small malignant growths can be cured by means of the local application of caustics, and large growths can sometimes be removed temporarily; and as this is easily done, charlatans have found a large field for work by appealing to the patient's dread of the knife, and promising to cure by milder means. While the patient is trying other methods than the one which surgeons of responsibility employ, the disease is usually getting such a foothold that opportunities for help are lost.

Many lives would be saved daily if cancer patients could be so educated that the delusions which lead them to tamper with so-called blood-purifying medicines and with irregular methods of surgical treatment would give place to fairly good reason. There are no secret methods of cure, notwithstanding advertisements to the contrary; and there are no ways or means for the cure of cancer that are not known to the responsible surgeons of all civilized countries.

Probably little can be done, however, in the way of directing the majority of patients properly, because the emotions of a victim of the disease are apt to be exalted, and the intellectual faculties are in consequence deprived of the exercise which they would have in conducting the ordinary affairs of life.

Legislation which prohibits illicit medical practice and the sale of useless medicines is becoming more and more strict in the European countries and in the large American cities, and it is through proper legislation alone that we can expect to see any marked decrease in the number of deaths which yearly occur from cancer.

THE INTERSTATE "LONG AND SHORT HAUL."

By HENRY WOOD.

THE passage of the Interstate Commerce bill marked a new era in national economic legislation. The immense magnitude of the interests involved, makes such a radical enlargement of legislative jurisdiction a very important event to the business interests of the country. In view of the bad effects of the long-and-short-haul clause which already have become apparent, it is assumed by many friends of the measure that there is a persistent effort being made on the part of the railway corporations to render the law odious, by the application of its provisions in an extreme and offensive manner. It is true that in many cases long-haul rates have been raised so as to correspond with the old short-haul tariff, instead of the shorter rates being reduced, and in the place of any such general and perfectly proportioned revision of tariffs as would be likely to exhibit the practical operation of the new law in its most favorable light. Such an effort on the part of railway managers could hardly be expected. It can not be denied that corporations are selfish, nor that their operations are conducted with a view to the largest possible ultimate profit. In this respect they are not unlike individuals who engage in business enterprises. In either case the motive is not philanthropy, but profit. While the object of the State in granting charters and creating corporations is the public good and convenience, the purpose of the individual corporators is gain. In any study of the relations existing between the public and the railways, these cardinal principles must not be overlooked.

Before examining specifically the long-and-short-haul clause, let us briefly consider the law as a whole, or rather the principles of general restrictive railway legislation. The recent rapid advance and expansion of legislative jurisdiction into new fields, and especially in the regulation of railway tariffs, where heretofore natural and elastic principles have been supreme, is a new departure of very doubtful utility.

An attempt to regulate *prices,* or *rates,* of any kind by artificial legislation, rather than by natural law, or supply and demand, is open to serious objections. The question which now forces itself upon the owners of the $4,000,000,000 (more or less) worth of railway property in the United States is, Where and when will the limit of legislative usurpation be reached? Where will the path lead which is being so rapidly traversed, and upon which such progress has been made in the recent past? It is evident to any candid and thoughtful observer that, if present tendencies continue unchecked, not only tariffs and incomes will be involved, but that the entire principal invested in these great interests will be jeopardized. The value of any investment depends entirely upon its earning capacity, or upon the benefit or increase that can be realized from it. If the present or prospective earning power of any property is impaired, then, in the same proportion, the principal invested in the enterprise will be diminished in value. Proceed but a step further, and wipe out the revenue-producing capacity, and the total value of the investment is destroyed. These points are so plain as to be almost self-evident, but yet there is danger of their being overlooked or ignored.

What will be the result if the prices for railway service and transportation are to be controlled by the uncertain and often unintelligent action of a bare majority of a popular body of legislators. If members of Congress were all intelligent and conscientious experts, and if railway legislation were free from the element of demagogism, the case would be quite different. We are, therefore, forced to the conclusion that the time may be not far distant when not only the tariffs, but the veritable *value* of railway property will depend upon the whim and caprice of a bare majority of the ever-changing politicians who compose our national Congress. The railway interest of the country may well shrink from a near view of the logical sequence to the socialistic demagogism now so prevalent both in Congress and outside of it. An increasing number of pseudo-political economists are advocating governmental ownership of railways, among whom are found a few prominent professors and clergymen, who are distinguished for their voluminous *theories*, but whose ideas are destitute of any practical element. Any plan of transferring the vast railway interests of the United States, with which our general prosperity is so bound up, from *business* to *political* control, seems unworthy of candid consideration. With assets of four billions added to spoils already too great, to be fought over every four years by politicians, together with the unlimited patronage connected therewith, the result would be certain and utter corruption and demoralization. Many sentimental and visionary persons idealize the *Government* into a great infallible, all-powerful personality, which makes no mistakes, and which can accomplish impossible things; but the *real* Government is very unlike this ideal.

But let us return to the question, What are the proper limits of railway legislation? Clearly within these limits may be mentioned all such advisory powers and offices as are exercised so successfully by the Massachusetts State Commission, including the protection of the public by all proper moral, mechanical, and police restrictions and regulations. To these may properly be added regulations against discrimination, and the doing away with the abuses of the "free-pass" system. On the other hand, the domain of prices and rates is distinctly and properly *outside* of legislative jurisdiction, and, for the general good, should be left subject to elastic natural laws. Price-making in any department is beyond the province of even the most perfect and ideal legislation. But some one will suggest, that while this proposition may be true of prices of commodities in general, that railways, having a semi-public character, and receiving by their charters certain privileges from the State, are exceptional in this respect. It will also be claimed that, in the absence of rate-restricting legislation, the public will have no protection against the rapacity of great corporations, whose object is solely their own profit. The fact is overlooked that, in the absence of legislative enactment, there is a sovereign *natural* law, which is fundamental in its character and unceasing in its operation. Entire dependence on demand, or the amount of business, forms a natural barrier against abnormally high rates, in addition to both direct and indirect competition. In tariff-making it hedges in the most powerful corporation.

Even in the absence of competition, any tariff that is much above the normal (or above that point which is natural and fair) will inevitably cause a falling off in business, so that profits will surely diminish. Though not always realized by the management, it is directly for the interest of any road to stimulate, develop, and increase its business by making a normal tariff, and only by such a course can the maximum of profit be reached. The greatest financial success lies directly in the line of the old adage, "Large sales and small profits." To quite an extent rates make themselves, and the arbitrary power of the management in this respect is greatly overrated by the general public. A railroad is not merely an improved public highway, but it is a complicated transporting machine. To successfully manage such an institution, or even to make, approximately, a perfect tariff, requires peculiar ability and talent, which is so rare that it commands a very high price. The tariff which is the most profitable for any given road, is not the one which is the highest, but that one which is the most perfectly adjusted, so that each kind and class of freight shall pay just what it will bear. Some will object to such an expression at first sight; but let us state it again, with an always understood qualification. A perfect tariff would be one so adjusted that each kind of freight would pay what it will bear, *compatible with its steady increase and development.* The profit lies in the increase of business, and not in abnormally high rates. It may be admitted that many roads often mistake their best interests in this respect; but experience is a persistent teacher, and, in the absence of legislation, rates have been tending steadily downward, and would have so continued. The principle is well illustrated by the successive reductions in the rates of postage. Within a short time after each reduction, the business has so greatly increased that, as a direct result, the profits have become larger than before.

Let us now briefly examine the point which is the cause of so much misapprehension in regard to the long and short haul. The provision that no more shall be charged for a shorter than for a longer haul, under substantially the same conditions, seems, at first sight, to be perfectly fair and just. But the business of transportation is peculiar, and unlike any other in which the absolute cost of the article can be estimated. The actual cost of transporting any given quantity of freight is not a fixed, but a variable quantity, depending on a great variety of circumstances and conditions.

If we examine the nature of the expenses of the average railway, we shall find that about one half of the total amount consists of what are known as "fixed charges," which are usually made up mainly of interest on the bonded indebtedness. Of the remaining expenses, which include the cost of operating, about one half may also be regarded as fixed in its character, so that, on an average, about three quarters of the entire expenses remain the same, whether much or little business is done. This explains why certain kinds of business which are *created* by remarkably cheap long hauls can be profitably taken at very low rates, for it is almost so much clear gain to the road. All the necessary help, track, appliances, and machinery must be maintained, *whether it is done or not.* Shorter-distance rates, though higher in proportion, are yet a little cheaper than they could be in case this special cheap, long-haul business is destroyed by legislative regulation. Many of these special kinds of business have already been paralyzed or temporarily destroyed by the operation of the "long-and-short-haul clause," and can only exist under former free conditions. If they are destroyed, the quota they have heretofore paid toward railway revenue must be made up by other classes of business, and shorter rates must, therefore, necessarily be higher than before. As an instance, the long-haul business between New Orleans and New York or Boston, now being done by water, will deprive certain roads of some revenue they have formerly received, and, as a result, they will have to make its place good by higher local rates. Such an effect will be inevitable in the long run. It will be seen that the free, elastic, and ever-present operation of natural law in this, as in other kinds of business, will produce better results for all concerned than is possible from any amount of uncertain, spasmodic legislation, which at best will be artificial in its character. Such enactments in the department of rate- or price-making will only tend to hamper and embarrass traffic, obstruct commerce, and aggravate the abuses which it is vainly hoped may thereby be cured. Supply, demand, and competition are like great ocean-currents, silent, but powerful, and any attempts to set up artificial barriers will always produce friction, confusion, and loss. In any contest between the natural and the artificial, the latter must yield, and, if resistance is made, harmful results will surely follow.

This has been illustrated by "Granger" legislation, usury laws, and, in a variety of other attempts to override natural law, by a harmful excess of legislative enactment. The question of the present time is, Shall commerce be permitted to run smoothly in its own natural channels, or shall it be hampered and obstructed by the changeable temper of uncertain and unintelligent legislation? *

VEGETABLE AND ANIMAL ALBUMEN.

By W. BERNHARDT.

HOWEVER numerous and prolific our investigations into the composition and properties of organic bodies may have been, we yet are very imperfectly acquainted with those processes by which these manifold forms of matter originate from simple constituents of air and water, and are as yet unaware of the causes on which the changes are depending that they undergo during life. We are acquainted with the artificial preparation of many of them, and still our experience is not sufficient to explain their natural origin.

We may produce oxalic acid, a body contained in the juice of many plants and also in certain animal secretions, by heating sugar together with nitric acid, but this is not the natural process of its formation, nor does it explain it. We imitate Nature in preparing grape-sugar from starch, but our method is different from hers, although the sugar we make by treating starch with hot dilute acids is identical with the product of the natural act of fermentation (caused in germinating grain by diastase, a product of decomposition of albuminous matter). It was considered a success of the highest scientific consequence, when Wöhler found out a way of artificially preparing urea, a matter resulting from

* Since this paper was written there has been another practical and important demonstration of the disastrous results of the long-and-short-haul legislation. The Canadian Pacific Railway, being free from any legislative shackles, is rapidly absorbing the traffic which otherwise would naturally seek the Pacific roads of the United States. A large diversion of the through transportation business from China and Japan has already taken place as a direct result of this remarkable policy of aiding our foreign rivals at our own expense. The handicapped condition of the American roads has been still further intensified in consequence of a recent renewal by our National Administration of a former concession, contained in the treaty of Washington, with her Britannic Majesty, which allows the transportation in bond of American merchandise from one port or place in the United States to another by a route, a part of which is by land-carriage, through the Dominion of Canada. By this means very large amounts of merchandise are now shipped from San Francisco and other American Pacific ports by steamers to the western terminus of the Canadian Pacific Railway, and thence brought over that line and distributed by American connecting lines to various commercial centers in the United States. Instead of fostering and building up the commerce of our own country, the Congress first takes away the freedom of competition from our carriers, and then our National Administration, while our legislative branch is not in session, restores to our rivals those special privileges which the Congress had abrogated in connection with the fisheries controversy. If such a peculiar joint policy by the legislative and Executive departments of our Government is long continued, and our Pacific roads can survive its effects, it will prove that they are possessed of great vitality.

the decay of muscular fiber in living animals; but yet, about sixty years after this event, we do not understand the chemical changes leading to that result. In a thousand other questions concerning the chemistry of human, animal, and vegetable organisms, our researches for finding satisfying interpretations have been futile, and even the most important query concerning the origin of life is likely to remain unanswered for many years to come.

There is a certain class of organic nitrogenous compounds, the origin, chemical nature, and decompositions of which are particularly far from being cleared up, although they concern the most indispensable functions of our own life, and are essential to vital energy in animals. Misunderstood, as many of their properties are, the facts which we know about them suffice to justify the high interest in their study which is manifested by chemists and physicians, as well as by the educated public in general. They are comprised under the name of albuminous matter, and have a very complex constitution, containing carbon, oxygen, hydrogen, nitrogen, and a small amount of sulphur. One of the chief features of their chemical character is a remarkable liability to decompose into the most various products. The best-known representatives of the group are—

1. Albumen, chief constituent of the white of egg and of blood-serum, dissolvable in water of common temperature, the dissolved matter coagulating and becoming insoluble when heated to 70° C.

2. Casein, dissolved as cheese in milk, coagulating upon addition of acids or certain ferments and warming.

3. Fibrin, coagulating from blood upon its exposition to air.

Plants are the manufacturers of albuminoids, or proteids, as they are also called; transformation of carbonic acid, water, and nitrogen, which are permanent constituents of the atmosphere and soil, into those combinations which constitute the body of plants, and which are designed to effect their propagation, is the chief function of the roots of plants. Among these combinations albuminoids are the most important, both for the vital process of the plants and as food for animals. From this reason the question of their origin has induced numerous investigations, to which we owe the knowledge that certain other nitrogenous bodies, called amides, which in varying amounts seem to be present in the roots of all plants at the time of beginning growth, play a prominent part in the genesis of albuminoids. The amides best known are asparagin (originally found in the shoots of asparagus) and leucin. The conclusion to which these researches have led is that sugar is formed in the root partly from starch by the action of diastatic ferment, partly by direct assimilation out of carbonic acid and water. Combination of sugar with one of those amides results in the formation of vegetable albumen, from which the rest of the proteids are derived by slight variations of chemical composition. Vegetable albumen being of a very unstable nature, is partly again decomposed into amides and sugar, and, while the latter is used in accomplishing the structure of the plant by changing into cellulose, the amide is again transformed into albuminoid, and by decomposition reduced to amides. Thus, by continually assimilating carbonic acid and water, combining with them to form albuminoids, and giving them off again as sugar, the amides act a prominent part in the development of plants. New supplies of amides, in the mean time, are continually formed, while the albuminous matter is partly transferred to remote organs, where, exposed to light and other agents, it undergoes various decompositions, by which the deposits of solid proteids, alkaloids, and many other bodies are produced. A certain quantity of proteids becomes stored up in the seeds, modified into gluten, or legumin, for the purpose of hereafter entertaining and supporting the life and growth of the offspring. Vegetable albumen, gluten, and legumin so closely resemble animal albumen, fibrin, and casein, that the same names have been given to them.

In thus tracing the origin of albuminoids in plants, we see them partly dissolved as vegetable albumen in the juice (upon the heating of which coagulated albumen gathers as foam on the surface), partly as "plasma" forming the contents of cells, and partly as solids in various organs, but chiefly in the seed, which by their presence acquires more or less valuable properties as food for animals, the nutritive value of grain and leguminous products being due merely to the high percentage of gluten and legumin contained in them.

Plants, indeed, are the sole source on which most animals depend for their food, for they are incapable of assimilating the constituents of air and water, as vegetables do. Only in the most simple forms of animals, such as moneres and amœbæ, the question is undecided whether such an assimilation takes place or not; but our knowledge of the limits between these low forms of vegetable and animal beings is very imperfect, and, in view of the numerous parasitic plants which draw their food from other organisms, we can not declare the source and process of nourishment to be a correct and pervading mark of difference between the two classes. If, however, some one should raise the objection that animals of prey do not depend upon plants for food, he might easily be corrected by showing that, in feeding on vegetable-eating creatures, they "indirectly" live on the plants themselves.

The changes which vegetable proteids undergo by being taken up into the animal organism are insignificant at first; having been transformed into soluble bodies (peptones) by pepsin, the digestive agent of the stomach, we see them appearing again in the circulation of blood as albumen, globulin, fibrinogen, combinations of very similar character to the proteids of plants. There is, indeed, no practical difference existing between albumens and legumins. The proteid of beans, peas, lentils, etc., is identical with casein, the proteid of cheese, as to composition and properties.

Blood, upon leaving the vein, is separated into a liquid and a solid part by fibrinogen, one of the proteids dissolved in it, undergoing a change, by which it becomes insoluble fibrin; muscular plasma, the semi-solid constituent of muscular fiber, by solidifying after death, and changing into fibrin, affords the well-known phenomenon of *rigor mortis*. It is a process closely resembling these, by which one of the soluble proteids of gluten, by accession of air and water, is transformed into insoluble gluten fibrin.

The conformity existing between the nitrogenous compounds of vegetables and animals is not limited to the proteids mentioned, but extends to various products of their decomposition. Diastase, the fermentative agent originating from proteids in the seeds of many plants during germination, is also present in the saliva of animals, where it exerts upon amylaceous foods the same action of forming sugar from starch. Agents very similar to pepsin, the digesting ferment of the stomach, are to be found dissolved in the juices of various plants; upon contact with muscular fiber, or coagulated albumen, or cheese, they will dissolve these bodies, and transform them into peptones as well as pepsin does. Thus papayotin, a substance extracted from the juice of *Carica papaya*—a kind of fig-tree—is therapeutically applied for dissolving morbid membranes and tumors; not less are the well-known insect-devouring properties of the leaves of *Nepenthes*, *Drosera*, and *Utricularia*, due to the presence of such ferments in their viscid secretions. Leucin and tyrosin, amides occurring in the roots of plants, which are both products of decomposition and regenerators of albuminoids, are also found in animal organs. The inflammation of skin, caused by touching a nettle, has been ascertained to be due to a kind of decomposed, or changed, proteid; and the virulent properties of the secretions contained in the venom glands of serpents having become known to depend on proteids, the conclusion appears well founded that the virus of insects and other animals also owes its pernicious effect to metamorphosed albuminoids, too, rather than to formic acid, as had been hitherto believed.

Many facts have been produced to show that, as the theory of evolution supposes, there is a degree of consanguinity existing between plants and animals: sexual differentiation, for instance, is common to the higher forms of both of them. Sexes in both cases are sometimes united in the same individual, sometimes separated. The lowest species of both of them, consisting of single cells, propagate by simple division. Scarcely a characteristic has been discovered in these living cells of plasma, which might justify the making of a distinction between plants and animals. The voluntary movement ascribed to the latter class is not plainly discernible in many cases, while many low plants, such as *diatomaceæ* and certain bacteria are eminently and continually engaged in lively motion. No striking difference is to be observed in the sources of food and in the way in which it is taken. If to these facts the results of chemical investigations be added, showing that many constituents of the greatest vital importance in both are identical, and that a close relationship of others (vegetable and animal fats) is beyond doubt, we may justly claim that chemistry has contributed and will further contribute considerable support to the doctrine of evolution, if identity of matter may be regarded as evidence of consanguinity, or as a proof of common descent.

Considered from another point of view the mutual relations existing between both classes of beings are of a decidedly hostile character. The fierce "struggle for life," which causes animals to kill and to devour their fellow-creatures, is in a not less merciless degree extended to plants; and victory is not, as we might fancy, always on the side of the more perfect creature. Even man, the most accomplished being, and at the same time the most relentless despot on the earth, though without much personal trouble he may fell the strongest trees and eradicate whole forests, is yet liable to succumb to the attacks of a few micro-organisms invisible to the human eye. A theory, at first pointed out by Pasteur, accepted by Virchow, and of late experimentally confirmed by Metschnikoff, teaches, that certain low plants, fungi, called microbia, or bacteria, said to be the primary causes of infectious diseases, when entering the circulation of blood or one of the important organs of the body, become at once engaged in a struggle with the living cells of the organism, both adversaries endeavoring to kill and to devour each other; the result of this fight, if the microbia are victorious, is said to be the death of the animal.

In a lively and perspicuous representation Metschnikoff has described one of these destructive combats. *Daphnia*, a sweet water crustacean, served to him as the first object on which he could observe the attack by monospora, a fungus of the lowest order. As soon as the latter began to invade the body of Daphnia it became surrounded and entangled by numerous cells (*leucocytes*) engaged in lively motion, which gradually from all sides attached themselves to the fungus and destroyed it by some kind of intercellular digestion, or absorption. It is evident, that a single cell could not afford to give out so much dissolving matter as was required for this purpose; it would even probably have succumbed to the enterprising enemy; but by the assistance of its confederates it succeeded in overwhelming the intruder. In eighty cases out of a hundred, according to Metschnikoff, the cells would be victorious, but in twenty cases the fungus would gain the battle, with the consequent death of the Daphnia.

Concerning this view and interpretation of the origin and progress of infectious diseases, we are inclined to believe that, since bacteria have not been found in all of them, and since, where they are present, also certain products of chemical decomposition of proteids, ptomaines, occur with them—the dangerous phenomena and the lethal end of such diseases should rather be ascribed to the well-known virulent properties of these products, as is done by many eminent physicians. Bacteria may frequently be the bearers and transporters of disease, as flies are accused of communicating the virus of splenic fever to healthy individuals.

The germ theory, which declares micro-organisms to be the cause and originators of infectious diseases, although it seems to be at present recognized by many physicians, perhaps by the majority of them, is as yet far from being thoroughly established. The action and influence of bacteria have evidently often been exaggerated. Pneumonia was ascribed to them, until it was found that in some pneumonitic cases bacteria are present, whereas in many others none could be found. In hydrophobia a particular micro-organism, although most eagerly sought for, has not yet been discovered. The possibility, however, of transferring this disease from one to another animal by inoculation indicates that the virus may consist of some kind of decomposed proteid, acting as a chemical ferment upon certain constituents of blood, or nervous substance. We may, by the existence of such ferments as diastase, pepsin, or as the virus of serpents and insects in healthy individuals, conclude that other not organized ferments exist in and are the cause of morbid conditions; and although most of the fermentative processes, on which epidemical diseases depend, seem to be induced and to increase by the agency and propagation of bacteria, there is no reason for making them accountable for other troubles to the extent that has hitherto been done. There are organized and unorganized ferments existing, both of which are known to produce decomposition of organic matter. We hope and expect that the future will decide what effects in animal and human diseases belong to each of them.

AN OUTCAST RACE IN THE PYRENEES.

UNDER the name of Cagots there live in the Pyrenees and the old Aquitanian regions on both sides of them—in the Spanish Upper and the French Lower Navarre, in Béarn, Gascony, Guienne, and Lower Poitou—a peculiar race who have been much talked about and have attracted the attention of the peoples about them from very ancient times. Formerly the Cagots (whose name linguists derive from *canis Gothicus*, Gothic dog) were confounded with Cretins. The association was a mistaken one for the Cagots, with their large, muscular forms, shapely skull, prominent nose, strongly-marked features, blue eyes, and smooth, blonde hair, are decidedly different from that weak-minded, deformed, and goitrous class; and their physical appearance, in fact, goes to sustain the etymology of their name that we have mentioned, and to indicate a possible derivation from the Aryan Goths. The type of which we speak also corresponds fully with the race-relatives of the Cagots living outside of the Pyrenees, who are variously called, according to the place, Cahets, Caqueux, Caquins, Cacoas, Colibrets, etc., and are spread to Lower Poitou, in Brittany and Marne, and far down into Spain.

The race of the Cagots was for hundreds of years superstitiously avoided by the other inhabitants of the country, despised, persecuted, repelled, treated as if abandoned and outcast, and restricted in all legal and social rights. Dark superstition and the prejudice of earlier times attributed to them a constant leprosy; they were supposed to have a peculiar repulsive exhalation, to be destitute of earlaps, to be color-blind, to see in the night like cats and owls, and were accused of pretended, likewise disgraceful offenses. They were treated as feeble beings, afflicted with contagious disease and moral impurities, who should not be touched, and with whom as little business intercourse should be had as possible. Down to the seventeenth century they were thus treated. If they lived in the towns, they were confined to a particular quarter in which the other citizens rarely came; if they came out of their quarter, they were obliged to wear a piece of red cloth on some conspicuous part of their dress, so that others might recognize them and keep away from them. On the plains they dwelt for the most part in miserable huts, which were separated from the town by a wood or by running water. In the church they were separated from the rest of the congregation by a wooden partition, and had to go in and out by a separate door. Holy water, the communion, and the other blessings of religion were forbidden them, and they could take part in the processions only under particular conditions; and the corpses of their dead were buried, without bells and music, in a separate burial-ground, or in a separate corner of the common cemetery.

The same kind of contempt and ill-treatment was measured out to the relatives of this race in other Pyrenean provinces, where they were formerly numerous, but have now nearly died out in consequence of persecutions. The Agotes, as they were there called, were formerly very numerous in the Basque provinces, and they can still occasionally be found sprinkled among the people. They were there equally despised and regarded as an unclean race, excluded from association with the rest of the people, compelled to seek abodes in caves, secluded hamlets, and miserable huts; they could fill no office; could not sit at table with other persons, or drink out of the same cup for fear that they would communicate some poison or impurity to the dish; and were not allowed to go into the church to receive their portion of the mass, but had to wait at the door till the priest brought it out to them. Marriage with them was as disgraceful as if it were with Moors, gypsies, or other non-Christians; and they were supposed to communicate disease and horrible ills to whoever touched them. The Cahets in Guienne were the objects of similar reproach and adverse regulations.

The reason of the superstitious prejudice and hatred against this people and their origin has not been discovered, although the subject has been an object of investigation and much discussion during the last four hundred years. The conjecture already referred to, which has long prevailed in France, that the Cagots and other despised castes in the Basque lands were descendants of the Visigoths, who were conquered by Clovis, and fled to the mountains, has been shown to be baseless and untenable. Many of the most esteemed and distinguished families of Gascony, Aquitaine, and Béarn were descended from the Visigoths; and those brave heroes were not afflicted with any of the personal defects, or anything like them, which were attributed to the Cagots.

Another conjecture, which was partly held to by the Cagots themselves, made them descendants of the Albigenses, whom Pope Innocent III outlawed and banished in the beginning of the thirteenth century. It is an historical fact that these poor persecuted heretics or opponents of the papacy were then regarded as the scum of mankind; but then they received in these districts of the present France more sympathy and adhesion than the popes themselves. Moreover, the Cagots were in existence as a despised race more than two hundred years before the crusade against the Albigenses. Pierre de Marca thought that the Cagots were descendants of those Moors from Spain who remained in Gascony and Aquitaine after their leader had been vanquished by Charles Martel on the slopes of the Pyrenees. But this view is contradicted by the decided northern type which is still recognizable in the bodily appearance of the Cagots, and by the historical fact that those Moors were eventually converted to Christianity, and became blended with the other French nationalities.

Caxar Amant ascribed a Jewish origin to the Cagots, and endeavored to sustain his opinion by a garbled quotation of a Biblical verse. Another writer made them descendants of the Jews who came to Southern Europe after the destruction of Jerusalem by Titus. Abbé Venuti supposed that they were descendants of Crusaders who returned from the Holy Land after the first Crusade, afflicted with disease. Count Gebalin saw in them the descendants of the aborigines of the Pyrenean lands, who were reduced to a condition of outlawry like that of the lowest castes and tribes in modern India. Another view, by which they were regarded as the descendants of those Spaniards who were in the conspiracy against Charlemagne and participated in the battle of Roncesvalles, has been disproved by a comparison of dates and places.

The later explanations of the origin of the Cagots are more plausible, though not quite historically convincing. A French investigator, M. Francisque Michel, has written a valuable book on the "History of the Accursed Races of France and Spain," in which he has sought with great consistency, as M. Louis Lande has also done in the "Revue des Deux Mondes," to prove that leprosy was the cause of the terrible and ignoble treatment which the Cagots have had to endure.

There is not in France or Spain any particular sect or district which has made itself conspicuous by the indefinite fear of these outcasts. But if we consider the popular belief, which persisted to a very recent period, that they had been or still were afflicted with leprosy, all will be made clear. Etymological research has shown that the name Cagot is associated with this disease in several of the French dialects. Evidently, if the fact or the opinion that the Cagots had been afflicted with leprosy was the provocative to the treatment which they had to endure in the dark ages, most of the prejudices against them would correspond with those which were formerly entertained against lepers. A later French writer, M. de Rochas, who has made a thorough study of the history and condition of the Cagots, in order to explore the subject to the bottom, made several journeys in the northern and southern outlying provinces of the Pyrenees during the last Carlist war, and visited some of the Cagots still scattered here and there among the population. He found everywhere that the descendants of the Cagots were quite like the rest of the population in bodily and mental characteristics, that they in no way suggested a strange origin, nor were they distinguished by any unusual or abnormal mark. He found, also, that while marriages of the Cagots with the rest of the population were rare, the two classes associated together on the same footing, their grown people and children attended the same churches, and that they both exhibited about the same degree of mental capacity. Every trace of leprosy, goiter, and cretinism has disappeared from among the Cagots of to-day. Some of them, it is true, are afflicted with scrofula, which, however, is not of hereditary or pestilential origin, but is traceable to poverty, insufficient food, poor, filthy houses, and physical neglect. In a Spanish commune, among whose inhabitants were many descendants of the once outcast race, M. de Rochas found those persons vigorous, healthy, sagacious, and apt; they were tilling small plots of ground, raising swine and hens, and pursuing about the same occupations as their neighbors. They were still patiently subject to a few of the old hostile usages of exclusion—for instance, to the prohibition of marriage outside of their own circle—but only because it was an old custom, for which they or their neighbors could not give a sufficient account. The members of the Cagot village were not physically or morally distinguishable from the rest of their countrymen; and it was plainly to be seen that the old prejudices against the Cagots had died out.

The French government and laws before the Revolution did very little for the protection of the Cagots. Better conditions have grown up since then. As soon as science began to busy itself with the investigation of the phenomena of Cagotism and to expose the baselessness of the prejudices against those people, the prejudices began to weaken; and they seem now to have quite disappeared.—*Translated for the Popular Science Monthly from Das Ausland.*

SKETCH OF SIR JOSEPH WHITWORTH.

THE value of Sir Joseph Whitworth's work, and the extent to which it has entered into common life, are exemplified whenever a screw-tap is fitted to a bolt. A biographical sketch of him, published on the occasion of his death, designated his name as the greatest of our time in mechanical engineering, and characterized him as a person of remarkable individuality and one whose efforts have left a permanent impress upon the workshops of the whole civilized world.

JOSEPH WHITWORTH was born at Stockport, England, on the 21st of December, 1803, and died at Monte Carlo, January 22, 1887. He was taught by his father, who was a schoolmaster, and at a school at Idle, near Leeds, till he was fourteen years old, when he was placed with his uncle, a cotton-spinner in Derbyshire. The operations of manufacturing were not to his taste, but he soon made himself at home with the machinery of the establishment, and in time became its practical managing engineer. After six years of this work he desired to find a wider field for the development of his mechanical abilities, and, although the value of his services was appreciated by his uncle, he ran away to Manchester, where he spent four years in acquiring a practical knowledge of the manufacture of cotton-machinery. Applications of steam-power were still new and crude, and tools adapted to use in connection with the new force were imperfect or wanting. In order to qualify himself to supply the need thus indicated, he went to London and sought employment in the best shops—Maudsley's, Holtzapfel's, and Clement's. Maudsley, recognizing his skill, took him into his own private room, and placed him next to his best workman. He worked in off-hours at his own devices, and in this way completed the true plane, an instrument which conferred the power of making surfaces for all kinds of sliding tools, by which the resistance arising from friction was reduced to its smallest figure, and of which he published a description in 1840. He showed his device and its operation to his fellow-workman, Hampson, who had been accustomed to ridicule his experiments, but now testified his appreciation of the work by saying, "You've done it." At Clement's he worked upon Babbage's calculating machine, which he always maintained would have operated perfectly if it had been gone on with ; and here also he learned to make a true screw.

In 1833 Mr. Whitworth engaged in manufacturing on his own account at Manchester, establishing himself in one room and putting out the sign, "Joseph Whitworth, tool-maker." It was in the infancy of extensive manufacturing, and there were no fixed standards of adjustment, no guarantees for accuracy of work, or attempt at symmetry or uniformity in any respect, but each maker was a rule to himself.

Whitworth foresaw that if industrial enterprise would prosper it must be systematized, and workmen must install harmony in their designs, and must aim at minute exactness in their forms and measurements. His attention was particularly directed to the inconveniences which were produced by the variations in the pitch and thread of the screws used in the construction of machinery—variations so considerable, if we may quote the words of an English sketch of his work, "that every maker had screws of his own special sizes, and that the failure of a single one might cripple a machine in a distant country until the original maker could be communicated with and could send out another of the same proportions. Mr. Whitworth not only saw the immense advantages which would arise from rendering the pitch and thread of screws uniform, but also the difficulty which might be experienced in inducing any maker to adopt the proportions used by any other. With rare sagacity, he obtained specimens of all the screws used by leading manufacturers, and then designed one which was the average of them all, and a copy of none. By this expedient he evaded opposition, and worked a revolution in the construction of machinery. The new screw was universally adopted; and, in the present day, every screw of the same diameter has a thread of the same pitch and of the same number of turns to the inch, and all screws of the same size, from whatever maker obtained, are interchangeable."

Mr. Whitworth next took up appliances for accurate measurements, and constructed an instrument capable of measuring the millionth part of an inch, and which, worked by touch, "was so delicate as instantly to communicate the expansion of a steel bar three feet in length when this was warmed by momentary contact with a finger-nail." With these and his other inventions, "Whitworth's standard gauges, his taps and dies, his uniform system of screw-threads, his great refinements in the manufacture of lathes, planing-machines, drills, etc., all became available at the moment when they had become indispensable, . . . if the imperative demands for mechanical appliances in every direction were to be worthily met."

In 1853 Mr. Whitworth was appointed a commissioner to the great exhibition in New York, and in that capacity wrote a report on American manufacturing industries which attracted much attention at the time, and still has interest. In the next year he was requested by the British Government to design and produce machinery for the manufacture of rifles for the army. He found it with the rifles as it was with nearly all mechanical appliances before he touched them to improve them—no two of them were alike. He imposed as a condition of his accepting the commission that he should be permitted to determine what form and dimensions of guns and bullets would produce the best results. Besides consenting to this condition, the Government erected a shooting-gallery five hundred yards long on Mr. Whitworth's grounds at Rusholme, where he was able to devote himself to most careful and thorough experiments. Here he determined the effects of every pitch and kind of rifling, and of every length of projectile, from the sphere to a missile having a length of twenty times its diameter; and the principles which he determined upon, of a projectile elongated to from three to five times its diameter, with a rapid rotation and a quick uniform rifling pitch of polygonal form, have been extensively adopted.

The same principles were found to be equally applicable to large guns, and the continued labors of the discoverer of them resulted in the production of the Whitworth cannon, which are declared to be the best the world has yet witnessed, "the most enduring, the most accurate, the most powerful in penetration, and the longest in range." But with all these advantages "the principles established by Whitworth were not adopted into the service, for reasons which it would probably be more curious than edifying to investigate."

Mr. Whitworth was embarrassed in the prosecution of his experiments by the difficulty of getting metal of the right kind. Mild steel, which gave the nearest approach to the desired qualities, was not wholly satisfactory, because the same properties which gave it toughness and ductility, gave also a tendency in the course of cooling, to imprison the escaping gases and cause unsoundness. To obviate this defect he applied the process of compression with hydraulic power, whereby the particles of the fluid metal were driven into closer contact and the gases were squeezed out. This process, by which the greatest strength was combined with the least weight and bulk, proved to be generally applicable, and is now largely employed for those structures in which it is desired that those qualities shall dwell together.

Early in 1869 Mr. Whitworth founded the Whitworth scholarships, assigning for the purpose £3,000 a year in perpetuity, or the interest on a capital sum of £100,000. The fund was vested in the President of the Privy Council, or other minister of public instruction for the time being, and was intended, as its institutor explained in a letter to Mr. Disraeli, to promote the engineering and mechanical industry of the country by a system of scholarship prizes to be made accessible on fairly equal terms of competition to students combining some practice with their theory, and to intelligent artisans uniting some theoretical knowledge with perfection of workmanship. The scholarships were valued at £100 a year, and were tenable for three years, to be obtained on competitions which were open to all Her Majesty's subjects at home, in India, and in the colonies, who had not completed their twenty-sixth (afterward changed to twenty-third) year. By regulations afterward prescribed to insure the holders of the scholarships devoting themselves to the studies and practice necessary for mechanical engineering during the tenure of the scholarships, it was required that every candidate should produce a certificate that he had worked in a mechanical engineer's shop or in the drawing-office of a mechanical engineer's shop, for two years consecutively; that he should be examined in the appointed sciences; in smith's work, turning, filing, and fitting, pattern-making, and molding, "as already established"; and that after 1875 each holder of a scholarship should be required to produce satisfactory evidence, by examination, at the termination of every year, that he had made proper advances in the sciences and practice of mechanical engineering. Additional prizes were offered for the best evidences of scholarship at the annual and final examination, so that it became possible for the best of the scholars at the end of his tenure of the scholarship to have obtained £800, and the others in proportion. The benefaction was added to, in 1875, by the foundation of a number of "Whitworth exhibitions."

Mr. Whitworth was made a Fellow of the Royal Society in 1857; he received degrees from Trinity College, Dublin, and the University of Oxford; obtained, in 1867, for his collection of engineer's tools and rifled ordnance and projectiles, at the Paris Exhibition, one of the five "Grando Prix" allotted to England; had conferred upon him by Napoleon III, in 1868, the decoration of the Legion of Honor; was awarded the Albert Gold Medal of the Society of Arts "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a degree of perfection hitherto unapproached"; and, in 1869, he was created a baronet, and became Sir Joseph Whitworth. He suffered for several years from the severities of the English winter, and went every year to the Riviera. Two years before his death he had built a winter-garden at Stanley Dale, to which he was confined for several months; but on the approach of cold weather in the fall of 1886, he determined, although he was so weak that his friends saw him depart with much misgiving, to try the Mediterranean coast again. "He leaves behind him," says the "London Times," "a reputation unapproached in his department, and he was scarcely less remarkable for the sagacity which he brought to bear upon great public questions, than for the severity with which he saw his conclusions put aside by men in official positions, whose minds were not mechanical, and toward whom his feelings scarcely rose to the level of contempt. The characteristics of his intellect were peculiar in that he was distinctly an experimentalist as opposed to a reasoner. When a problem in mechanics was presented to him, it was his habit to say, 'Let us try,' and he possessed the rare gift of being able to devise conclusive experiments." His principal published book was a collection of "Essays on Mechanical Subjects," including true planes, screw-threads, and standard measures, which was published in 1882. He left a large part of his estate to be applied to purposes of instruction in mechanical engineering.

CORRESPONDENCE.

A DIFFICULTY REGARDING EVOLUTION.

Editor Popular Science Monthly:

THE article of Professor Joseph Le Conte in the "Popular Science Monthly" for October, upon the subject "What is Evolution?"—the clearest, fullest, and fairest presentation of the subject we have ever met with—suggests afresh an insuperable difficulty to our entire and hearty acceptance of the doctrine of evolution. With a view to obtaining light upon this dark part of the subject, we beg leave to state it in as brief space as possible. And in doing so, we indulge no conceit that we are the first either to experience the difficulty or to call public attention to it. We simply affirm that we have never met with any explanation whatever of it in any of our not very extensive scientific reading.

After putting forth his admirably conceived and worded definition of evolution, Professor Le Conte remarks that "Embryonic development is the type of evolution." It is just here, in this typical expression of evolution, that our initial difficulty arises. It is this: Is there in all the realm of organic life a known embryo existing (that is living) apart from its parent organism? Must we not have the latter before we can have the former? True, the chicken is evolved from the egg; but who can determine which, the chicken or the egg, was first in order of time? We no more have any knowledge of an egg ever having existed independent of the agency of a mature male and a mature female organism, than we have of the existence of a chicken that was never hatched from an egg.

And if we go back of the egg or the embryo a step, and consider that primal substance of organic life, protoplasm, is it not equally true of this, that it is nowhere found, except as a part of or a belonging to some organic form? Is it not in fact a secretion, a vital fluid product of a living organism? And has protoplasm ever been separated from its normal organic *locus*, without thereby involving an immediate destruction of its potentiality? Who, therefore, may affirm that protoplasm is the antecedent, the primordial phase of organic life, rather than the reverse of the statement?

The procedure from protoplasmic spherule to mature organism is not a final or complete one; for, no sooner has the organism attained its full growth, than in conformity to the law of propagation—as much a law of organic being as growth itself—it at once proceeds to reproduce itself. And so the processes of life, when viewed in their entirety, would seem to constitute a circle, every point of which is equally instinct with progressive vitality, and whose most complex phase (the organism) is immediately joined to the simplest phase (protoplasm). Who, therefore, may put his finger on the embryonic cell and say, "Here was Nature's starting point," with any greater assurance of the absolute truth of his position than another may claim who believes that in the mature organism exists the real source, the fountain-head of life?

We are free to confess that, of the two hypotheses just noticed, the one which places the possible initiative of organic life in possession of a mature organism, seems to us by far the more patent, the one most nearly in accord with the hourly teachings of surrounding nature. Like Ajax, we petition for light. M. K. ROYSE.

CINCINNATI, OHIO, *October*, 1887.

WHY HAVE WAGES RISEN?

Editor Popular Science Monthly:

IT would be difficult to praise too highly the articles of Hon. David A. Wells, on "Economic Disturbances since 1873," in late numbers of the "Popular Science Monthly." To read them has been a delightful experience, but there is one question which I am surprised to find that he has not brought forward, and that is, why have wages for manual labor risen to such a height when all other prices have been falling to lower and still lower marks for fourteen years? Almost every argument that Dr. Wells has adduced to account for depreciation elsewhere, would assist in proving that labor should also be low. Overproduction, while cheapening the product, should cheapen the work that produces it, and if it be said that machinery by doing so much and by multiplying the efficiency of each pair of hands causes the money paid for labor in our large industrial establishments to be relatively but a small part of the cost of production, thus enabling capital to pay and labor to exact higher wages for work, the comparative poverty of cotton and woolen-mill operatives and of women who run sewing-machines, does not sustain this view of the case. There are few circumstances connected with the economical disturbances of to-day so difficult to account for or whose consequences reach so far and are so generally felt as the increase in laborers' and mechanics' pay. With the day's work rated at one dollar, farming here at the East would be a remunerative occupation, but with wages at twelve and fourteen shillings agriculture in New England is dead. A gentleman, whose little fortune of $10,000 brought him at 7 per cent an income of $700 just before the war, thought himself on a somewhat higher social plane than his neighbor the carpenter who, working 240 days out of the 365 at $1.50 per day obtained $360 for his year's labor; but nowadays receiving $720 for the same labor for the same period, the mechanic looks down condescendingly upon the possessor of ten myriads of dimes, whose annual income at 4 per cent is reduced to $320 less than his own; and, to beautify this picture by adding the proper sidelights and shadings, the property-holder is heavily taxed to educate the carpenter's children while he, the carpenter aforesaid, howls for higher wages and less hours of work and weeps copiously over the oppressive rapacity of capital. One might proceed through all social grades and all human occupations, and everywhere find high wages effecting disturbances in some cases beneficial, in others disastrous, but always attended by low prices for everything else and by circumstances which should depreciate the price of labor also, and yet it would seem that the workman is most in demand and paid the best where his products are most overproduced. Why should this be so? Will the Hon. David A. Wells attempt an answer?

W. B. WEED.

DARIEN, CONNECTICUT, *December*, 1887.

OYSTER-FATTENING.

Editor Popular Science Monthly:

SIR: I have only to-day had the good fortune to see Professor Atwater's most interesting paper on the chemistry of oyster-fattening. I am induced to say that thirty to thirty-five years ago it was common for well-to-do families in the North of Ireland—County Derry—to buy oysters by "the long hundred," that is one hundred and twenty, and to lay them down in tubs or pans in fresh water, with a very little salt added. When they had been so laid down a few hours, some oatmeal was thrown into the water, in pinches, and they were thus "fed" for two or three days when they were found heavier, plumper, and more delicate in flavor. If I recollect rightly, they were also made whiter by this process. Was the effect wholly imaginary, or did the oysters really assimilate the oatmeal, which was always of the finest, that is, the flouriest, sort?

Yours truly,

CHARLES WILLIAMS, F. R. G. S.

NEW YORK, *November* 22, 1887.

EDITOR'S TABLE.

THE "ACT OF GOD" AND "HUMAN RESPONSIBILITY."

NOW and again, amid the rush of modern progress, we catch a note or sign of reaction. Such a note we most distinctly have in the article published a couple of months ago in "Science" over the signature of Mr. Appleton Morgan. Mr. Morgan is a lawyer of distinction, whose talents have been largely employed by railway companies, and who has thus naturally contracted a sympathy, very allowable in its way, for those corporations. But to say that Mr. Morgan is a lawyer in active practice is almost tantamount to saying that his line of thought and argument on any given practical subject will be forensic rather than scientific—that is to say, that it will be skillfully adapted to lead up to a prearranged conclusion rather than to bring out all the truth that is obtainable in connection with the matter in hand. Mr. Morgan writes a clever article to prove that some railway accidents proceed from causes so far beyond human control that we might properly apply to them the old expression, "the act of God." The suggestion is that in such cases the railway companies should hardly be held accountable. What we are not given, however, is any clear principle of distinction by which accidents for which railway companies might, in Mr. Morgan's opinion, properly be held accountable may be separated from those where all responsibility fails, and "the act of God" must be invoked as the only hypothesis suited to the case. Yet, without some such clear principle of distinction, the whole of Mr. Morgan's labored argument rests *in nubibus:* it is very fine, from the special pleader's point of view, but we get no practical results from it.

We have spoken of this article as a note of reaction, and so, most emphatically, it is. The progress made in modern times has consisted very largely in the banishing from our thoughts and calculations of all faith in occult agencies, and in the establishment of the habit of tracing everything that happens to some intelligible, if not always controllable, cause. So long as sprites, goblins, and imps were seriously believed to interfere in human affairs, so long it was impossible to hold men to a strict responsibility for their actions; and when things went amiss, no truly scientific inquiry into the causes of the mischance was ever instituted. To say that it was "the act of God" was the easiest way out of the difficulty, and the most satisfactory, certainly, to those upon whom the blame might properly have fallen. But science has been teaching mankind to search out real causes, and to dismiss purely imaginary ones; and just as the disposition to do this has developed, and just as men have been taught that they can not put all their sins of omission and of commission on the shoulders of invisible agencies, have accidents and irregularities of all kinds diminished in number. Mr. Morgan admits this. He says that, up to a very recent date, courts of justice habitually saved time and routine labor by assuming accidents, the causes of which could easily have been arrived at, to be "acts of God." He tells us that, in a very recent case, while the principle involved in the expression, "the act of God," was recognized by the court, it was held that a shipwreck, in order "to be a veritable act of God, must have occurred in extremely bad weather." We should rather have supposed that the "act of God," if recognizable at all, would have been recognized in the foundering of a ship in calm weather. It was the thunder-clap that he heard from a clear sky that so strongly affected, for a brief period, the not ordinarily very devout mind of the poet Horace; and Mr. Morgan seems so far to agree with that "sparing worshiper of the gods" as to hold that in the case of railway accidents the "act of God" is most visible, not when the conditions are unfavorable, but when, on the contrary, they are highly favorable, save in the one point in which a quasi-supernatural interference is exemplified.

Admit the principle in question at all, however, and we are back in the dark ages; we cease, indeed, to be fit to run railways. It is one thing to bow with resignation to a calamity after it has happened, and quite another to anticipate that calamities will result from the "act of God," and so far make provision for them beforehand. How is the "act of God" to be checked? How are we to prescribe the frequency with which such acts are to be performed? If, in the presence of such acts, we really find ourselves outside of the bounds of human responsibility, why try, by any human means, to guard against their recurrence? We venture to say, however, that no railway accident ever occurred that was not followed by more or less strict inquisition into its cause, and that did not give rise to measures intended to prevent the same thing happening again in the same way. Some of the facts mentioned by Mr. Morgan himself tend to show how little need there is to have recourse to divine intervention to explain the occurrence of any class of railway accidents. He tells us that until within a very few months the strides made by science "seemed to have happily abolished—in the United States—the great railroad disasters of the past." Fifteen or twenty years ago there were a number of frightful accidents, but since that time accidents involving great loss of life have been very infrequent.

Now we plunge once more into an era of disasters. But what does this suggest, if not that prolonged immunity from accident due, as Mr. Morgan says, to the strides of science and to skillful organization, had led to a less vivid realization of the dangers attendant on railway traffic, and a consequent relaxation of vigilance. This is just what would naturally happen, so why invoke the "act of God" to explain what natural principles are quite sufficient to account for? All things tend more or less to move in cycles; all action, we might almost say, tends more or less to polarize itself and so to check or reverse its current. Thus prolonged immunity from disaster tends to weaken that very realization of danger which is the first condition of safety. Hence follows, in natural sequence, a relaxation of the rigorous discipline to which safety had been due; and then we have not long to wait for such accidents as Mr. Morgan would fain persuade us are to be classed as "acts of God." Again, Mr. Morgan tells us that "however we may explain it, it happens to be one of the most persistent of truths that accidents are of more frequent occurrence upon bankrupt or non-dividend paying, than upon solvent and dividend paying, railroads." Truths are very apt to be persistent when they rest upon some permanent principle; and in this case the explanation of the truth mentioned by Mr. Morgan is very obvious. The solvent and flourishing railroads can afford to pay for, and do pay for, better service than the bankrupt and decaying ones; and the better service gives better results in point of safety—leaves less opportunity for "acts of God." If Mr. Morgan's "truth" was not so persistent, or if it was persistent the other way; and if it could be shown either that the ratio of accident did not depend at all upon vigor of management, or that the more vigorous the management the greater the number of unaccountable accidents, then there would indeed be something to say for the "act-of-God" theory. It is strange that Mr. Morgan should dwell with such emphasis upon a truth that tends so directly and persistently to contradict his own thesis.

But what are the railway companies to do, it may be asked, if things naturally move in cycles, and if accidents are therefore liable to follow in ordinary course upon a period of freedom from accidents? We answer that it is for man in the maturity of his intellectual development so to take account of the action of natural laws as to provide against their injurious results. It is a law of Nature that metal expands with heat and contracts with cold, but the pendulums of clocks meant to keep accurate time are not left on that account to undergo all the vicissitudes of temperature. The voltaic cell is not left to polarize itself out of all usefulness, nor the furnace-fire to quench itself with its own ashes. In every such case, as soon as the law is observed, measures are devised, with more or less success, to introduce such compensations or rectifications as may be required; and we refuse to believe that compensatory measures of an entirely analogous kind could not be introduced in the railway service of the country to prevent safety from polarizing itself into disaster.

We quite fail to see what Mr. Morgan hopes to gain for his argument by remarking, as he does more than once, that the disasters he cites—those, namely, at Republic, at White River Junction, at Forest Hills, at Chatsworth, and at Kouts' Station — happened "from the simplest natural causes," and might have happened equally to the rudest vehicular contrivances of primeval or prehistoric man. As to the natural causes, of course they are simple enough: a bridge that is half burned away can not be expected to possess the strength of one in perfect order; nor can one constructed on bad principles and of inferior material be expected to keep itself in position after all the strength it ever had has been jarred out of it by several years' traffic. Nothing, indeed, could be simpler than all this; but how is the responsibility of the railway companies of to-day to be lessened by the reflection that the rude ox-teams of prehistoric man were also subject to vicissitudes? No doubt a badly-made ox-cart would be liable to break down, just like a badly-built bridge of modern days; but what bearing has that on the present question? Mr. Morgan tells us of a certain Philares (by which we suspect he means *Phalaris*) who used to roast his subjects for his amusement in the interior of a brazen bull; and he says, no doubt with great truth, that the railway companies are not of this disposition, and moreover that a modern railway accident, considered as a means of cremation, is very costly—much more so than the half-cord or so of wood used for heating up the brazen bull. All very true. We quite admit that the companies would like to avoid accidents and save costs of all kinds; but we say that nothing will hold them to a determination to do so, so far as the utmost exertion of vigilance and the employment of the very best appliances can avail for the purpose, so much as the knowledge that, if their system breaks down *at any point*, they are responsible to the last dollar. We quite agree with Mr. Morgan that newspaper declamation as to the "greed" of companies is often wide of the mark and quite undeserved; but we also believe that such declamation, even when it is most out of place, is not calculated to do half as much harm as his reactionary plea for a division of responsibility for railway accidents between the companies and some occult agency wholly inaccessible to human prediction and to human control.

LITERARY NOTICES.

The American Journal of Psychology. Edited by G. Stanley Hall, Professor of Psychology and Pedagogics in the Johns Hopkins University. Vol. I, No. 1. Baltimore, Md.: N. Murray. Pp. 203. Quarterly, $3 per year.

This journal is to be heartily welcomed and commended. It supplies a genuine want, and if the first number is a fair sample, its work will be well done, and a great credit to American science. The object of the journal "is to record the psychological work of a scientific as distinct from a speculative character, which has been so widely scattered as to be largely inaccessible save to a very few, and often to be overlooked by them." The journal is to consist of three parts: "*I. Original contributions of a scientific character.* These will consist partly of experimental investigations on the functions of the senses and brain, physiological time, psycho-physic law, images and their association, volition, innervation, etc.; and partly of inductive studies of instinct in animals, psychogenesis in children, and the large fields of morbid and anthropological psychology not excluding hypnotism; methods of research, which will receive special attention; and lastly, the finer anatomy of the sense-organs and the central nervous system, including the latest technical methods, and embryological, comparative, and experimental studies of both neurological structure and function; *II. Digests and reviews*, and *III. Notes, news, brief mentions, etc.*"

The number before us contains leading articles, entitled: "The Variations of the Normal Knee-Jerk and their Relation to the Activity of the Central Nervous System" (with plates), by Warren Plympton Lombard, M. D.; "Dermal Sensitiveness to Gradual Pressure-Changes," by G. Stanley Hall and Yuzero Motoro; "A Method for the Experimental Determination of the Horopter" (with plate), by Christine Ladd-Franklin; "The Psycho-Physic Law and Star Magnitudes," by Joseph Jastrow, Ph. D. In addition there are sixty pages and more of reviews of psychological literature, covering thirty-eight works reviewed—American, English, French, German—the reviews being of unusually excellent quality. Finally, there are ten pages of interesting notes, giving items of psychological importance.

Since the publication of "Mind" was commenced, no periodical has appeared of such fair promise for the promotion of psychological knowledge and inquiry. Professor G. Stanley Hall has made his mark in this department of science, and is thoroughly equipped for the work of conducting such a journal. We wish the enterprise every success, and believe that it will receive a cordial support from all those who are competent to judge of the value of a scientific pursuit of psychological study.

The Science of Politics. By Walter Thomas Mills. New York: Funk & Wagnalls. 1887. Price, $1.

This book is not exactly what its title would seem to indicate. The author defines political science as the science of the state and also of citizenship, but the latter is the exclusive subject of this work. It does not treat of the functions of the state or of its historical evolution, but of the practical duties of the citizen, especially with regard to political parties. Hence, it is practical rather than philosophical, and for that very reason will probably interest a larger number of readers. The style is journalistic, and the book is cut up into a large number of short chapters, so that it reads like a series of newspaper articles.

The author's views on the subject of parties are, for the most part, those of the best public opinion of the country at the present time. He holds fast to the doctrine that a political party exists solely to carry into effect some recognized principle or principles which its members believe in, and consequently that when a party refuses to act on principle it has no longer any reason to be. He is no believer in the doctrine that a man must always indorse the action of his party, whether he approves it or not; and he has a clear sense of the despotism of party managers and of the mischief they often do. He shows that a party is not, like the state itself, a permanent organization, but a temporary one, and that when a party has outlived its usefulness it ought to perish and give way to a new organization that will deal with the problems of the day. He is, perhaps, a little too ready to break off from established parties because of disagreement with them on a single issue, the particular issue that he is interested in being that of prohibiting the sale of liquors. But he shows throughout his book the preference of public ends to private and partisan ones which is now happily characteristic of the best young men of America. In short, while there is little in the book that will be new to the political philosopher or the instructed statesman, there is much that will be useful to ordinary voters if they should study it.

We are sorry to find the book disfigured by a great number of misspellings, such as "weich" for which, "squarly" for squarely, "Leiber" for Lieber, and so on, some pages having two or three words misspelled. Such blunders are not creditable to either author or publisher.

The Gnostics and their Remains, Ancient and Mediæval. By C. W. King. New York: G. P. Putnam's Sons. Pp. 466. With 15 Plates.

The author's original work upon Gnostic remains was published about 1864, and met with strong commendation or reprehension, according as it fell in with or contradicted cherished notions. The most really complimentary criticism to his own mind was the assertion made by one reviewer that he had displayed in the work more the spirit of a Gnostic—that is, of "one addicted to knowledge"—than of a Christian. He claims to have continued to pursue his investigation with the motive thus described, of studying the subject for the sole purpose of understanding the truth. New and extremely valuable sources of information have come to his hand since the publication of the first edition, to which no previous author had access: in the shape of the tract the "Refutation of All Heresies," by an author, perhaps Origen or Hippolytus, who was intimately acquainted with the doctrines he exposed, and illustrated them by many extracts from the Gnostic literature, then copious enough; and of the "Pistis Sophia," the only one left of the once numerous Gnostic Gospels, and a most important book for his own purpose. Mr. King's especial field of research is the archæological side of the subject, the philosophical side having, in his opinion, been satisfactorily treated by Matter ("Histoire critique du Gnosticisme," 1827), to whom the reader is referred. The history and origin of the system, its relations with other systems from which it was derived or has borrowed its rituals and its emblems, come under his purview. He begins by reviewing the great religious systems of the East, which were flourishing at the time of the promulgation of Christianity in those regions, with the influence of those systems upon the modes of thought and expression of both the missionaries of the new creed and their exponents. He cites from the words of St. Paul evidence of the previous existence of the germs of Gnosticism in the cities that were the scenes of his most important labors. Proof is brought forward that the seeds of Gnosticism were originally of Indian growth and were carried westward by the movement of Buddhism, which was planted in the dominions of the Seleucidæ and the Ptolemies "at least as early as the times of the generation following the establishment of those dynasties." Next, are considered the contributions of Egypt, which are discriminated from the real Gnostic productions, and have their distinctive characters pointed out; Mithraicism, with explanations of its alliance with Occidental Christianity; the religion of Serapis, the last of the heathen forms to fall before the power of Christianity; "Abraxas, Abraxaster, and Abraxoid gems," and their meaning; the relations of astrology, the Templars, the Rosicrucians, and the Freemasons; with observations about the origin of Mason's marks, and talismans, and amulets, which are related by their nature to this religion; "for Gnostic symbols and Gnostic formulæ gave their virtue to many of the class, being borrowed directly from the Gnosis or from the older creeds out of which the latter was constructed. Their employment, and the notions generating them, have been here described, showing the derivation of many of the mediæval examples from the Gnostic class; and by following out the same principle, it has been attempted to find a key to their cabalistic legends which may fit them better than any hitherto offered by their interpreters." The illustrations are drawn entirely from engraved stones, for the Gnostic societies erected no monuments to attract public attention. They include various types of the god Abraxas, Cnuphic and Serapic emblems, Egyptian types, Mithraic subjects, talismans, Hindoo symbols, and Mason's marks. The book promises to be of great value to the student, but can hardly be comprehended without some previous knowledge of the subject.

Elementary Psychology and Education. By Joseph Baldwin, of Texas. International Education Series. New York: D. Appleton & Co. Pp. 287. Price, $1.50

This work is intended expressly for elementary classes. The author says: "Our literature is rich in psychologies adapted to colleges and senior classes in our normal schools, but is destitute of a text-book suitable for our high schools and for the lower classes in our normal schools. The want of such a text-book is widely felt. The author has given the best years of his life to the effort to prepare such a text-book and thus meet the want. Each lesson here submitted has been given scores of times to large classes with highly satisfactory results. Short sentences in plain Anglo-Saxon is the rule. Object-lessons, bold type, outlines, study-hints, examples to work out, original analysis, original definitions, original applications, and helpful illustrations, are called into constant requisition."

The plan of the work is to deal in Introductory Lessons with Attention, Instinct, and Sensation; in Part II with the Perceptive Powers; in Part III with the Representative Powers; in Part IV with the Thought Powers; in Part V with the Feelings; and in Part VI with the Will Powers. Diagrams for the purposes of illustration are abundant. Topical analyses are made at the close of each chapter, together with Suggestive Study-Hints. The typography of the book is excellent.

Boston School-Kitchen Text-Book. By Mrs. D. A. Lincoln. Boston: Roberts Brothers. Pp. 27 + 237. Price, $1.

The purpose of this manual is a very important one, for it aims to supply what many young women undertake the management of a home without—namely, a knowledge of the proper methods of preparing and combining foods, and especially the reasons for these methods. Recipes have their place in the book, but more prominence is given to general principles—to explanations of the nature and uses of food, of the changes effected by the several modes of cooking—baking, boiling, steaming, and broiling—and to principles for adapting the diet to age, occupation, climate, and means. The practical directions include the care of the fire, and the cleaning of utensils, the names of the cuts of beef, with diagrams, the care of food before and after cooking, and laying and waiting on the table. Invalid cookery also receives attention. Tables of the cost of meats and fish, and charts showing the average composition of some common foods are given. The language is adapted to the understanding of young girls, and the book is indorsed by the Superintendent of the Boston Public Schools as being the outgrowth of practical teaching in the cooking class-rooms connected with the public schools of that city.

Ancient Nahuatl Poetry. Containing the Nahuatl Text of Twenty-seven Ancient Mexican Poems. With a Translation, Introduction, Notes, and Vocabulary. By Daniel G. Brinton. Philadelphia: D. G. Brinton. Pp. 177. Price, $3.

The Nahuatl tongue is one of the most highly developed of American aboriginal languages, and is represented in a relatively rich literature, of which the present volume embodies perhaps, some of the most important specimens. The race who spoke it cultivated song, music, and the dance, with passionate love, and held the profession of poet in the highest honor. The poets' works were recited by themselves or by professional singers at public meetings and on festal occasions, as were those of Homer, the troubadours, and the Welsh bards. The old love of the song and the dance are continued, Dr. Brinton tells us, in the Indian villages to this day, with changed themes, but in forms which have undergone but little alteration. The more important songs were written down by the Nahuas, according to Sahagun, in their books, and from these were taught to the youth in the schools. The sound as well as the sense of the sentences and verses was also preserved by the method of writing which Dr. Brinton has described in a monograph that has been noticed in the "Monthly" as ikonomatic. By these methods, a large body of poetic chants was in existence when the Nahuatl-speaking tribes were subjugated by the Europeans. Some of them were translated into Spanish by Sahagun, and others were preserved in the original tongue; and thus they came to the knowledge of European writers. The question having been raised whether any ancient Mexican poetry is now extant, Dr. Brinton explains that his text is taken from a copy made by the late Abbé Brasseur de Bourbourg, from a manuscript volume in the library of the University of Mexico, composed of various pieces in different characters, which were attributed by the antiquary, Don José F. Ramirez, to the sixteenth and seventeenth centuries. In the editor's view they are from different sources and of different epochs. The collection includes a notice of the LX songs of the royal poet King Nezahualcoyotl, who died in 1472, with translations of four of the poems, and the text and translations of the twenty-seven songs mentioned in the title, which are of various moods. Not a line of these songs, the editor asserts, has ever before been rendered into a European tongue. The introduction includes notes on the Nahuatl national love of poetry, the status of the Nahuatl poet and his work, the themes and classes, prosody, and vocal delivery of the songs, the instrumental accompaniment, the preservation of the ancient songs, and the history of the present collection. The thanks of all students are owing to Dr. Brinton for the diligence and enthusiasm—with no little self-sacrifice, we judge—which he has displayed in bringing this aboriginal literature series to its present fulness. The publication can not be supposed to be a profitable or paying one, yet he has kept it up without discouragement and without depreciating the quality of the work. Abundant material remains in his hands for a continuation of the series, and other works of a similar character with those that have already appeared will be issued from time to time if sufficient interest is manifested to meet the cost of publishing them. We hope that this interest will be shown, and the enterprise not allowed to become a burden to the editor.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. XXXII. Popular Tribunals. Vol. II. San Francisco: The History Company. New York: Frank M. Derby, Eastern agent. Pp. 772. Price, $5.

The present volume of Mr. Bancroft's great work is devoted to the history of the second Vigilance Committee of San Francisco, or that of 1856, and is dedicated to its president, William T. Coleman, who is styled the "chief of the greatest popular tribunal the world has ever witnessed." The Vigilance Committee of 1856, while it was of similar composition and of the same character and spirit of that of 1851, rose under different circumstances, and to meet a different emergency. At the time of the earlier committee, law had not been established, but San Francisco was still the prey of ruffians who had been attracted from all quarters by the stories of the gold-diggings to which it was the gate, and who overrode all legal restrictions by brute force. In 1856 government had been organized, and might have been strong enough if it had chosen to exert itself, but was under the control of political tricksters, assisted by the roughs. Hence there was more apparent reason in 1856 in favor of the plea that reform should be sought through legal measures, and for the clear difference of opinion which existed between evidently honest and well-meaning men as to the propriety of the Vigilance Committee's existence and the justification of its measures. Hence, also, a more temperate style than the author of this history has permitted himself to use through most of his work would have been more becoming its sober purpose. The Vigilance Committee of 1856 was a movement by the vast majority of the people of San Francisco against systematic ballot-box stuffing, which made fair elections impossible and all elections burlesques, universal thievery, and political terrorism intensified by frequent murder; all tolerated and said to be encouraged by public officers who depended on such outrages to reach and hold their positions. These abuses had grown up since the former Vigilance Committee had finished its career five years before, in consequence of the easy-going citizens leaving politics to the politicians. It was called into being by the murder of James King, of William, editor of the "Bulletin," by James Casey, following close upon the murder of United States Marshall Richardson by Charles Cora, an Italian gambler. King's offense was denunciation of the wrongs, and particularly of Cora's crime, and attacks upon Casey, who had interested himself in Cora's defense. Casey was believed to be backed by prominent politicians, including Judge McGowan of one of the city courts, himself a formerly convicted bank-robber. As it seemed morally certain that these criminals would not, be punished, as others like them were not, the substantial citizens took matters into their own hands, and at a public meeting reorganized the Vigilance Committee, which had never formally surrendered its life. This committee was a public affair, the names of its members were known, its acts were open, and its proceedings governed by fixed rules. During the three months of its activity—from the middle of May to the 18th of August, 1856—it hanged four men, banished about thirty, rescued—that is, took possession of—two prisoners from the county jail, and held a judge of the Supreme Court under arrest, waiting the death or convalescence of his victim. Its proceedings were objected to, as those of the Committee of 1851 do not seem to have been, by a considerable party of good citizens, whose quality may be judged from the fact that William Tecumseh Sherman was one of them. The city authorities were against it, of course; the Governor of the State made feeble and futile attempts to suppress it, and efforts were made to embroil it with the United States authorities. In spite of all it went on with its work, and when it had done, adjourned *sine die*. It must be judged by its fruits. Seven years after King's death, the People's Reform Party were able to show in an appeal to voters which is too long to quote here, but which is given in full in the 656th and 657th pages of the volume, that San Francisco had, from being the very focus of peculation, disorder, robbery, and murder, under uninterrupted honest rule, become one of the best ordered, safest, and most prosperous cities in the world. This was accomplished while national politics were kept out of city affairs. Then the people's party, under the pressure of a great national emergency, adopted a political resolution—and its usefulness was gone. In this simple fact lies a plain and impressive lesson, which is taught throughout the history; and for the sake of this lesson, if for no other reason, the study is a most valuable one.

Science Sketches. By David Starr Jordan. Chicago: A. C. McClurg & Co. Pp. 276. Price, $1.50.

Professor Jordan presents in this volume a collection of scientific essays, some of which have appeared previously in "The Popular Science Monthly" and elsewhere, the others being addresses not before published. A majority of the papers are on fishes, the study of which has been the scientific specialty of the author. Among these are "The Story of a Salmon," "Johnny Darters," and "The Dispersion of Fresh-Water Fishes." There are also three sketches of a biographical character on Darwin, "An Eccentric Naturalist" (Rafinesque), and "A Cuban Fisherman" (Poey). The other papers comprise "The Nomenclature of American Birds," "The Story of a Stone," "An Ascent of the Matterhorn," and "The Evolution of the College Curriculum." These are all of a popular character, and written in a pleasing style, though without sacrificing scientific accuracy. A list of the author's scientific papers, numbering two hundred and fourteen, is appended.

Elements of Modern Chemistry. By Adolphe Wurtz. Third American from the fifth French edition. Translated and edited by William H. Greene, M. D. With 132 Illustrations. Philadelphia: J. B. Lippincott Co. Pp. 770. Price, $2.50.

The most striking feature of this book is its comprehensiveness. The natural occurrence and extraction or laboratory preparations and the properties of the elements and their compounds are described with great fullness, and enough subjects are presented to occupy an academy or college class for at least two years. Most of the theoretical matter is included in the first fifty pages, but a few topics are inserted at later points. Nearly half of the volume is devoted to the compounds of carbon. In choosing which facts of organic chemistry to present, the author was guided by "the historical importance and the theoretical and practical interest of the compounds described." In each of the three American editions, the editor has rearranged and added to the matter in order to better adapt the work for American use. "The present edition contains additional matter embracing the more important advances of chemistry in the last three years. Among the additions may be mentioned the history of the isolation of fluorine, the monoxide of silicon, the Castner sodium process, and the electrical furnace. Wherever new investigations have shown statements accepted formerly to be erroneous, corresponding corrections have been made."

Decisive Battles since Waterloo. By Thomas W. Knox. Illustrated. New York and London: G. P. Putnam's Sons. Pp. 477. Price, $2.50.

This work is designed to cover the period since 1815 in the same manner as Professor Creasy's "Fifteen Decisive Battles of the World" covered the period "from Marathon to Waterloo." The fact that Mr. Knox finds twenty-five "decisive battles" in the annals of the past seventy years, seems to indicate either that the world is not really passing out of a military into an industrial stage, as has been asserted, or that our author has been more comprehensive than discriminating. Some ground for the second alternative is given by the statement in the preface that "the book has, however, for its further purpose, the idea of presenting an outline survey of the history of the nineteenth century, considered from the point of view of its chief military events." These words describe the book better than its title, for each chapter includes, besides the account of an important battle, also a sketch of the whole campaign in which the battle occurred, and in several cases minor wars, which were marked by no battle of a decisive character, are touched upon in order to give continuity to the record. The first battle described is that of Ayacucho, in 1824, which terminated the Spanish rule in South America. The battles of Prome, in Burmah, and of Staoueli, in Algiers, and the siege of Silistria, on the Danube, are among the less known operations which are included. Four battles of our civil war are ranked as decisive, viz., that between the Monitor and the Merrimac, Gettysburg, the capture of Vicksburg, and Five Forks; two of the Franco-Prussian war, Gravelotte and Sedan; and two recent British disasters in Egypt, El Obeid, and the fall of Khartoum. The author partly disarms criticism as to his selection, by saying that it is unlikely that any unanimity of opinion could be found among historical students of the present day on this subject. Mr. Knox is best known as a writer of juvenile books of travel and biography, and his style in this volume is popular, displaying much of the picturesqueness which fascinates his younger readers. A general statement of his sources of information is given in the preface, but there are no specific references to authorities in the text. The volume has no index.

United States Commission of Fish and Fisheries. Part XIII. Report of the Commissioner for 1885. Washington: Government Printing-Office. Pp. 112 + 1108.

This bulky volume testifies to the industry of the Fish Commission during 1885. The report gives a general survey of the work of the year, and to it are appended thirteen reports of steamers and stations, including one on the thermometers used by the Commission, by Dr. J. H. Kidder, and twelve other papers on special topics. Among the latter is an account, by Captain J. W. Collins, of the fishing-grounds examined during a cruise along the coast of the South Atlantic States and in the Gulf of Mexico. This paper contains much information in regard to the methods and results of the sponge, turtle, and other fisheries of Key West and the fisheries of Western Florida, in which the red snapper, pompano, sheep's-head, Spanish mackerel, mullet, etc., are caught. Under the head of scientific investigation are two papers on the development of the cetaceæ and of osseous fishes, by John A. Ryder; one on the decapod crustacea of the Albatross dredgings, by Sidney I. Smith; one on the *Annelida chætopoda* from Eastport, Maine, by H. E. Webster and James E. Benedict, and another by John Murray and A. Renard, read before the Royal Society of Edinburgh, on the nomenclature, origin, and distribution of deep-sea deposits. There is a catalogue by David S. Johnson, supplementary to the "Synopsis of the Fishes of North America," issued in 1883, and comprising additions and corrections accumulated during 1883 and 1884, and also a list, with descriptions, of patents of 1882–'84 relating to fish and fisheries, illustrated with one hundred and fifty plates. Many of the other papers are copiously illustrated.

Second Annual Report of the School of Expression, Boston: S. S. Curry, Dean. Pp. 3.

The School of Expression has grown out of the work of the School of Oratory which was opened at Boston University some fourteen years ago. Its aim is not merely to educate one phase of the delivery, but to include training for the complete control of the body and the whole mechanism used in speech, and also to give practical discipline of the imaginative, sympathetic, logical, and dramatic instincts. The first endeavor is to secure correct intellectual, emotional, and volitional action in all kinds of reading and speaking. The mechanism used in speech is developed, and ease, agility, and precision of action without waste of the vital force are sought through careful and thorough vocal training; while other exercises look to the development of poise, ease, precision, and harmony, flexibility, and strength in the whole organism. The theory of the school is, in short, "to secure control of every agent and develop its distinct function in expression."

Proceedings of the Biological Society of Washington. Vol. III., July 1, 1884, to February 6, 1886. Pp. 180.

Besides the journals of the several meetings of the society, this volume contains the annual presidential addresses of Dr. C. A. White (1883) on "The Application of Biology to Geological History," and of G. Brown Goode (1886) on "The Beginnings of Natural History in America." Dr. White elucidates, in opposition to the European theory of the synchronous character of similar deposits of fossils, the idea of homotaxy, as proposed by Professor Huxley to express the existence of close biological relationship between formations in different parts of the world which might not, or could not, have been contemporaneously deposited. Dr. Goode's address we have found extremely interesting. It gives a clear account of the progress of observation and the growth of science in this country from the first observations of Oviedo y Valdes in 1525, and Thomas Harriott, of Virginia, in 1590, through a considerable list of original contributors, to the end of the last century. The men whose names are mentioned, the author says, "were the intellectual ancestors of the naturalists of to-day." The volume also contains lists additional and supplementary to those heretofore published, of flora of Washington and vicinity.

United States Department of Agriculture. Report of the Entomologist for 1886. By C. V. Riley. Pp. 144, with Plates. Reports of Experiments with Various Insecticide Substances. Pp. 34. Our Shade Trees and their Insect Defoliators. By C. V. Riley. Pp. 69. Washington: Government Printing-Office.

Besides the general review of the work of his bureau by the Entomologist, the "Report" contains papers on the "Cottony Cushion Scale," "Buffalo Gnats," the "Fall Web-worm," and "Joint-worms"; each paper embodying a description of the insect, an account of its depredations, and suggestions of remedies. A paper on "Silk Culture" represents the prospects of this business in the United States as not yet hopeful, but speaks well of the Osage orange as a food-plant for the silk-worm. Reports of agents are given upon various insects affecting small grains and grasses; and the last paper is a "Report on Experiments in Agriculture." The experiments with insecticide substances of which the second pamphlet gives accounts, were directed chiefly to insects affecting garden-crops, and were performed at Ames, Iowa, Lafayette, Indiana, and Trenton, New Jersey, with ice-water, chemical solutions, and vegetable decoctions. They are described in detail. The insect defoliators of shade-trees whose cases are considered in the third pamphlet are the imported elm-leaf beetle, the bag-worm, the white-marked tussock-moth, and the fall web-worm. The information given is full. As "one simple preventive remedy for all," spraying the trees with arsenical mixtures in the middle of May, and once or twice at intervals of a fortnight later in the season, is recommended.

Modern American Methods of Copper-Smelting. By Edward D. Peters, Jr. Illustrated. New York: Scientific Publishing Co. Pp. 342.

It has been the intention of the author of this book to confine what he wrote, with few exceptions, to his own experience, and to present no more of the theory of the subject than is essential for understanding practical operations. A feature of the work is the estimates of cost, both of plant and of operating, which the author has presented in considerable detail. In order to keep the volume within moderate size, the so-called "wet methods" have been excluded. After a description of the methods of copper-assaying practiced in this country, he describes the several ways of roasting lump-ore and matte, recommending for the building of roasting-stalls "slag-brick" molded in sand. The calcining of fine ore and matte is then treated, and a short chapter is given to the chemistry of the calcining process. The smelting of copper comes next in order, and this naturally falls into the divisions of smelting in blast-furnaces and in reverberatory furnaces. Dr. Peters maintains the general excellence of the American form of the blast-furnace process, while admitting the necessity of using reverberatories for certain portions of the matte concentration in many cases. A few pages on separating the precious metals from copper, and on Bessemerizing copper mattes are added.

The Conception of Love in Some American Languages. By Daniel G. Brinton. Philadelphia: McCalla & Stavely. Pp. 18.

Premising that the words which denote love picture the heart of those who use them, the author has studied their history and derivation in the American languages as furnishing evidence of the development of the altruistic principle among the races, and as illustrating the wonderful parallelism which everywhere presents itself in the operations of the human mind. The most prominent words relating to love in the Aryan languages may, in the author's view, be traced back to one or two ruling ideas—one intimating a similarity or likeness between the persons loving, and the other a wish or desire; the former conveying the notion that the feeling is mutual, the latter that it is stronger on one side than on the other. The subject is studied from this point of view in the Algonquin, Nahuatl, Maya, Qquichua, and Tapi-Guarani languages.

The Relations of Geology and Agriculture. By W. J. McGee. Washington: Judd & Detweiler.

This paper is an address which was delivered at the meeting of the Iowa State Horticultural Society in 1882. The author's object is to point out the importance of applying geologic principles to the investigation of the soil. It is premised that the soils of the earth are immediately derived, through mechanical and chemical action, from the underlying deposits forming the subsoil—pre-eminently the agencies with which the geologist has to deal. The application of the principle is illustrated by citations from the author's studies of the drift of Iowa.

An Inquiry into the Transmission of Infectious Disease through the Medium of Rags. By Charles F. Withington, M. D. Pp. 69.

The author concludes that small-pox has been transmitted through the medium of rags, to an extent which though not great, is sufficient to show that there is real danger in the matter; and that the source of the infection is more frequently domestic than foreign rags. Among the rarer means whereby cholera is transmitted are textile fabrics infected with choleraic discharges. A solitary case is reported, but not fully accredited, of transmission by paper rags; if substantiated, it also will be an offense by domestic rags. Cases have occurred of an epidemic affection of anthrax called "rag-sorter's disease" caused by handling rags. Authenticated cases have not been found in which the other infectious diseases have been transmitted through rags; and there is no evidence to show that rag-sorters as a class are essentially less healthy than other persons engaged in indoor operations. Still precaution should be taken against possible danger from rags coming from epidemically infected places, and paper-mills should have means for purifying their rags, and ventilating means for guarding against dust-poisoning; and whatever precautions are used should be applied as much to domestic as to foreign rags.

Bulletin of the Iowa Agricultural College, from the Botanical Department. Byron D. Halsted, Sc. D., Professor of Botany.

The study of botany is pursued in regular course in the college beginning with the second half of the freshman year. The instruction consists of observations of actual plants assisted by Gray's text-books, beginning with leaves and flowers, their forms and arrangement. The studies in the sophomore year are taken up before the opening of spring, upon branches and buds. During the spring, each student prepares an herbarium of fifty species, collected and determined by himself. The work is continued during the year in morphology and the general characteristics of plants; and the pupils are exercised in special topics of research in which they prepare papers from their own observations. In the junior year cryptogams and vegetable physiology are studied; a course in applied botany is given, and three hours a week of laboratory work are provided for. A variety of experiments are recorded, and numerous special papers, mostly brief, are published in the second part of the "Bulletin."

The Best Reading. Third Series. A Priced and Classified Bibliography, for Easy Reference, of the more Important English and American Publications for the five years ending December 1, 1886. Edited by Lynds E. Jones. New York and London: G. P. Putnam's Sons. Pp. 108. Price, $1.

Every one who knows the first and second series of this work will eagerly welcome the present volume. To those who have not used the preceding volumes, it may be said that no bookseller, no one who buys books for his own or for a public library, and no one who reads systematically, or has occasion to direct the reading of others, can afford to be without "The Best Reading." An explanation of the letters and stars used to indicate the character of books should have been inserted in this volume.

Winter: From the Journal of Henry D. Thoreau. Edited by H. G. O. Blake. Boston: Houghton, Mifflin & Co. Pp. 439. Price, $1.50.

This volume is made up of passages entered by Thoreau in his journal during the winter months from 1850 to 1860, with occasional entries of earlier dates. The scenes alluded to are along the Concord River and about Lake Walden, with occasional visits to other places. These pages reveal how much of interest a lover of Nature can find in the fields and waters during the season when Nature is commonly said to be asleep, and are interspersed with reflections suggested by winter objects.

Astronomical Revelations. New York: Edward Dexter. Pp. 62. Half morocco. Price, $2.

This is a contribution to theoretical astronomy, in which the author confidently claims that "the true physical causes of the precession of the equinoctial points, the apparent secular acceleration of the moon's mean motion, the decrease in the obliquity of the ecliptic, the apparent aberration of the stars, and the apparent nutation of the earth's axis, are now for the first time made known and explained." A theory of the physical nature of the fixed stars is added, which regards them as reflections from the diversified surface of a solid shell inclosing the solar system.

Stories of our Country. Historical Series, Book III, Part I. Compiled and Arranged by James Johonnot. Illustrated. New York: D. Appleton & Co. Pp. 207. Price, 47 cents.

The design of this book is clearly expressed in the preface: "By the use of this little work, the pupil has all the aids to reading which characterize ordinary reading-books—lessons for practice, variety in style, and all the necessities of elementary elocution. Besides these, he gets all the interest that the story excites, the knowledge which it unfolds, and the sentiment which it imparts, and the reading-lesson becomes a potent force in mental and moral development." The selections relate to the early explorations of America, to colonial times, and the Revolution, with a few stories of the War of 1812 and the Mexican War. They have an intensely vivid character, which is heightened by the spirited illustrations. Such a book as this can not fail to fascinate the pupils for whom it is prepared, and turn the lesson which was a hated drudgery with the old-fashioned reading-books into a delightful exercise.

Second Annual Report of the Forest Commission of the State of New York. 1886. Albany. Pp. 177.

The secretary of the commission, Mr. A. L. Train, who prepared this report, states in a prefatory note that as the commission has not been supplied with funds for investigations, experiments, surveys, etc., information obtainable only by such means can not be expected in the report. He has accordingly presented an account of what work the commission has been able to do since its appointment, together with a compilation of facts and opinions bearing on the subject of forestry, which might enlist "the aid of the people more earnestly in the important effort to maintain the remnant of the forest area still left to them." The commission has already secured the payment into the State treasury of $14,057.09 for trespasses, and for timber illegally cut on State lands, and has stopped, probably permanently, these illegal practices. Another result of its work is the suppression of forest fires during the past year.

Cottage Residences. By A. J. Downing. Edited by George E. Harney. Illustrated. New York: John Wiley & Sons. Pp. 261.

The original wide scope, refined taste, and practical character of this work made it of lasting value, and its worth was increased by the revision and enlargement which were given to its fifth edition in 1873. The guiding principle of the author was to combine the beauty of sentiment and of propriety with fitness, and with each design is given a suggestion as to the character of the natural surroundings to which it is best adapted, together with directions and diagrams for laying out ornamental grounds, kitchen-gardens, and orchards. The revision of the book comprised the modifying of the estimates of cost to agree with changed prices of labor and materials, the substitution of new lists of plants and trees for those formerly given, together with the addition of twelve new designs for buildings, some further hints on gardens and grounds, and remarks on the employment of architects and contractors.

Manual of Clinical Diagnosis. By Otto Seifert and Friedrich Müller. Translated from the third (revised) edition by William B. Canfield. With Sixty Illustrations. New York: G. P. Putnam's Sons. Pp. 173. Price, $1.25.

This manual comprises concise directions for the various clinical examinations which yield the data for medical diagnosis. It contains, also, facts and figures which the physician should always have available, yet which are too numerous to be remembered correctly, and too widely scattered through books and periodicals to be readily referred to. The favor with which the book has been received in Germany has led to this translation.

An extended and richly illustrated work on "The Fishes of North America" is announced by Mr. William C. Harris, editor of the "American Angler," who has spent five years in collecting the material for it. Many months of this time were spent on selected fishing waters, with a skilled artist in company with the author, who, working upon the shore or in the stern of the boat, painted the portraits of the specimens immediately after they were caught, while the lively coloring and evanescent sheen were still upon them. The portraits are given in an upright position, as in the act of swimming, with all the markings, even to the exact number of spines in the fins, faithfully reproduced. The publication will be issued in monthly parts, with pages twelve by seventeen inches in size, which will contain each: Two portraits of fishes, colored as in life; scientific classification and description; local names and habitat; when and where caught; method of capture; tackle and lures used; and striking incidents of capture. The work will be issued in forty parts, containing the portraits, etc., of eighty fishes. Price, $1.50 a number.

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POPULAR MISCELLANY.

Mr. Lockyer's Theory of "The Cosmos."—Mr. Lockyer has presented, in a paper to the Royal Society on the "Spectra of Meteorites," a new hypothesis concerning the origin and nature of the stars and other celestial bodies. Among the fundamental propositions of his theory are those that all self-luminous bodies in the celestial spaces are composed of meteorites, or masses of meteoric vapor, produced by heat brought about by condensation of meteor swarms due to gravity; that the spectra of all bodies depend upon the heat of the meteorites, produced by collisions, and the average space between the meteorites in the swarm, or in the case of consolidated swarms, upon the time which has elapsed since complete vaporization; that the existing distinction between stars, comets, and nebulæ rests on no physical basis; and that the main factor in the various spectra produced is the ratio of the interspaces between the meteorites to their incandescent surfaces. These, with other propositions of more detailed and specific character, are sustained by results of spectroscopic examinations of meteorites and of various substances, which are described particularly. Experiments prosecuted for fourteen years have shown that the luminous phenomena manifested by the several classes of heavenly bodies can be reproduced in the laboratory by subjecting meteorites, as far as possible, to conditions similar to those assumed by the hypothesis to exist in space. Thus, the reproduction of the spectrum of the sun by the fusion of meteorites in the voltaic arc accords with the supposition that it is the result of the condensation to the point of complete volatilization of an originally sparse swarm of meteorites. The spectra of comets when near the sun give the lines of a meteoric body glowing in a dense atmosphere given off by itself when highly heated; while at their greatest observed distances from the sun their spectra are identical with those of the nebulæ, which are supposed by the hypothesis to be "closely associated with a meteorite glowing very gently in a very tenuous atmosphere given off by itself." Hence nebulæ are supposed to be sparse clusters of associated meteorites, and their luminous phenomena to be due to the glow of gases which result from collisions between the individuals of the group. Comets are nebulæ whose proper motions have brought them within the range of the sun's attraction; but when outside of his more immediate influence they exhibit no phenomena which are not also exhibited by nebulæ. The next stage of approximation is exhibited by stars designated as of Class III*a*, and is due to the attraction of gravity among the individual meteorites of the swarm; and the succeeding stages are indicated by the increasing complexity of the spectra, whether of the meteorite itself rendered incandescent by collision of the vapors by which it is immediately surrounded, or of the general interspace between meteorite and meteorite. At this point the direct evidence of the spectroscope fails us. The force of gravity which has drawn the meteorites gradually together must still continue to operate, but as its operations become more intense the collisions will become more frequent, until at last the meteorites are completely volatilized by the heat evolved, and in that case the star becomes a mass of incandescent vapor at a transcendental temperature. We know that such stars exist, but we can not produce their spectra in the laboratory because we have no means of obtaining the temperature required. The condensation is now complete, and the highest temperature capable of being evolved by the forces at work has been attained. When gravity has resulted in the complete volatilization of the gravitating bodies its power is exhausted, and the process of cooling must thenceforth set in. This stage is exhibited in the stars of Class II, of which our sun is the most familiar example. The stars in Vogel's Class III*b* once more exhibit spectra capable of approximate reproduction in the laboratory, and thus show that they have returned to a temperature no longer transcendental. The last stage of all is that of stars, or bodies associated with the stars, so cool as no longer to be incandescent. The spectroscope tells us nothing of them, but there are good evidences of their existence. Is this the end? We can not say so with any confidence. We have no right to say that collisions can not occur between the larger bodies as well as between the meteorites. Then "the cycle of the universe would be complete, and we might say of the Cosmos as the geologist Hutton said of the earth—that it exhibited no trace of a beginning, and no evidence of an end. This, however, is pure speculation."

Antiquity of North American Flora.—Reasons are adduced by Mr. A. T. Drummond, in his discussion of the distribution of British North American plants, for supposing that America was the starting-point of that phase of the vegetation which, in its later development, has become the flora of to-day. The first undoubted evidences of this flora, on any considerable scale, are found in the Leda clays of the Ottawa Valley. The Eocene flora resembles, not so much the Eocene as the later Miocene of Europe. Seeing that the Eocene and Upper Cretaceous of North America, in the resemblance of their flora to that of northern temperate America of to-day, are older than the European Cretaceous and Eocene, that it was only in later epochs in Europe that the generic identity with North American plants became so very distinctly marked, and that in Europe many of the genera of the Pliocene identical with those of to-day have since become extinct, "there seems a possible presumption," says the author, "quite apart from that derivable from their present range, that some of these identical European and American plants may be older in America, and being northern temperate in range may have originated in northern temperate America."

The Peabody Museum.—The latest—the twentieth—annual report of the Peabody Museum of American Archæology and Ethnology records the complete affiliation of that institution with Harvard University by the installation of its curator, Dr. F. W. Putnam, as professor there. This position imposes no duties which the curator of the museum has not already performed, they consisting only of the delivery of one or more courses of lectures annually; but it brings the museum more closely into the general system of the university. The archæological work which the museum has in hand includes explorations in Nicaragua and Costa Rica through the co-operation of Dr. Earl Flint, in the course of which many relics, including some of jade, have been recovered, and human foot-prints have been found in volcanic tufa sixteen feet below the surface; continued explorations by Dr. C. C. Abbott, in New Jersey, which have yielded, in fragments of human skeletons associated with the stone implements in the glacial gravel, the earliest record of man on the Atlantic coast; the explorations of the shell-heaps of Maine, under Dr. Putnam's personal supervision, which have brought to light many interesting facts relative to the early occupation of New England by man; the ethnological researches of Miss Alice C. Fletcher among the Omaha and Sioux Indians, which is growing into a history of the tribes, with a description of their social and religious customs; and the explorations in the mounds and burial places of the Scioto and Little Miami Valleys of Ohio —the most extensive and systematic of the museum's explorations—which have yielded extremely rich results in illustrating the life and customs and rituals of the people to whom they appertained. To these may be added the decipherment and translation by Mrs. Zelia Nuttall of a number of the Mexican codices and inscriptions.

The Scientific Privileges of Country Boys.—"Nor is the study of natural things, and the making of discoveries," says Professor O. P. Hay, in a paper on "The Amphibians and Reptiles of Indiana," "the exclusive privilege of those who have received a scientific training. There is not a farmer boy in Indiana who may not make solid contributions to science if he will but use his opportunities. Persons who live in the country are in direct contact with Nature. They see a thousand things that the naturalist would delight to see, and yet may never be permitted to behold. The time of coming and going of the various species of birds; their curious habits, as shown in nest-building and obtaining food; and the occurrence here and there of rare species of various animals, are examples of matters which all may observe and report, and which science needs to know."

Rich Men's Duties to Themselves.—While the value of wealth as an alleviator of suffering and a promoter of worthy public objects is strongly appreciated by many who possess it, says Lester F. Ward in "The Forum," "its value as a direct means of intellectual and moral culture is rarely discerned by this class. Many rich people are fully alive to their duty toward others, and at the same time apparently devoid of a sense of their duty toward themselves. The function of wealth, in affording leisure for culture and for thorough, painstaking work in any field of progressive labor, has always been and always must be a far more important one than that of furnishing temporary relief to suffering humanity. Without leisure, Humboldt could not have explored all the realms of Nature, and given the world an intelligible cosmos. Without immunity from care, Newton could not have found out and unfolded to his age and ours the true nature of the universe. Without leisure and resources, Darwin could not have fathomed the mysteries of life and solved the great problem of being. Civilization, with all its mechanical accessories and blessings, is the product of calm deliberation and patiently-wrought results. The inventions that underlie it were impossible until the principles of Nature upon which they rest had been established, and this has in most cases been the result of prolonged researches made for truth's sake alone. . . . This scientific work, this search for truth for its own sake, can only be successfully prosecuted when the means of subsistence are made to be not in the least dependent upon it. . . . The so-called men of leisure, who have accomplished these good results, have really been the most industrious of all men. Leisure, in this sense, merely means relief from the necessity of performing statical work, in order to be able to perform dynamic work. . . . But how few understand it in this sense!"

New Economical Plants.—The directors of the Sahárunpur Gardens, India, are cultivating a number of new plants, for acclimitization. Among them is the *Acacia Senegal*, which, besides yielding the best gum-arabic, furnishes a reddish-brown wood which takes on a fine polish, and is used for weavers' shuttles. The *Cedula adorata*, or West Indian cedar, has a light wood of a mahogany color, even-grained, easily worked, and fragrant—the wood from which Havana cigar-boxes are made. *Cencheris catharticus* is a much-valued fodder-plant, which grows in sandy-desert tracts. It is the *Tuart* of Australia, a tree of magnificent proportions, which furnishes most excellent hard-wood timber. The *Myricas*, or wax-myrtles, of North and South America, are cultivated for the waxy exudations on their fruits, from which the wax is separated by boiling and skimming. The fruits of the *Sapindus saponaria*, or West Indian soap-berry, contain a large quantity of a saponaceous matter, which is used for washing clothes. The hard, round, black seeds are worn as beads for necklaces.

How to be a Good Nurse.—Six things, says a doctor writing on the subject, are necessary to a good nurse: Strong, equable health; sound nerve; minute observation; a retentive memory; habits of neatness and cleanliness; and a calm, collected mind. A nurse must never disregard her health, because it is essential to her own well-being, and because, too, attendants on the sick should always be cheerful and hopeful. Sound nerve is often a matter of training, but its root lies in unselfishness. Any one who, in an accident or operation, forgets self in the desire to aid others, will not be troubled by trembling or fainting. The faculties of observation and retentiveness of memory can be developed by having interest in the work strong enough to make the nurse careful and patient in her observations. A calm mind is generally the result of organization. If a nurse has arranged her day's work beforehand, if she keeps everything punctually to this arrangement, and if everything needful is neatly disposed, she is not likely to be discovered in bustle and confusion at any time. The nurse should, furthermore, be mindful that she is under the doctor, and should respect and obey his directions even if she differs in opinion from him. It is extremely important that those who are sick and suffering should be treated with unfailing gentleness and patience; nothing can ever excuse a nurse for losing her temper with her patient. No duty is too little or trifling for her attention, and no work that is for the good of the patient can be degrading. It is further a good rule never to approach a case fasting; but always to have a good meal before going on duty.

Notes about Maple-Sugar.—According to a pamphlet on "Maple-Sugar and the Sugar Bush," by Mr. A. J. Cook, trees growing on high, gravelly soil are supposed to supply richer sap, while those on clay or muck yield more abundantly. Exposure to the open sunlight is favorable to a good yield. Concerning the influence of the preceding season on the supply, opinions differ. Vermont sugar-makers believe that an open winter is conducive to a good flow and richness of sap, while those of Indiana and Michigan think the reverse. North and west winds and clear skies are favorable, while east and south winds and the approach of a storm are unfavorable. An increase in the amount and richness of the sap has been noticed after a rain. A layer of snow or frozen ground over the roots of the tree is thought to be conducive to a bountiful yield. The deeper the bore of the tap, the longer the sap will continue to run; but a small hole gives nearly as much sap as a large one, with considerably less injury to the tree. While the sugar-maple is the best for sugar, the other maples are often tapped; but it is an objectionable feature in them that the buds start earlier, causing an increase in the amount of inverse sugar and other changes that give a bitter taste. The average yield per tree is probably two or three pounds, but single trees have been told of which gave thirty or forty pounds. Some sixteen or twenty quarts of sap are required to give a pound of sugar. Mr. Cook estimates the profits of his own sugar-bush at ten per cent on the capital invested, with no risk; and the business promises to become more and more a source of profit each year. For, "the maple-sugar industry is so limited by the very condition of things, and its product is so incomparably superior to all other like products, that we need fear no dangerous antagonism, no impoverishing competition. We have, and can always keep, the monopoly." The care and extension of maple-sugar plantations are therefore advised.

Curiosities of Guessing.—Some curious facts bearing on the "Eccentricities of Guessing" were communicated to the American Association by Professor T. C. Mendenhall. The author had formed a standard probability curve which could be applied to any form of guessing, and which represented the law that governed the occurrence and recurrence of purely accidental things. This standard was seldom deviated from to any considerable extent. He had frequently tested the accuracy of the probability curve by experiment. A large number of persons guessed at the number of nails of various sizes contained in a carboy. The lowest guess was 43; the highest between 3,000,000 and 4,000,000. Eight guesses came within one of the actual number, six falling short, and two exceeding it, while a vast majority came within a few hundred of it. It was 2,551. Many terminated their guesses with the figure 7; then 3, then 9 came in the order of preference. Odd numbers occurred three fourths of the time; and the number of the year was frequently chosen.

Electric Tractive Adhesion.—Mr. Elias E. Ries exhibited, in the American Association, his method of using the electric current for increasing the tractive adhesion of railway-motors and other rolling contacts. The electric conductors are connected with the driving-wheels of the motor-car by means of contact-brushes in such a manner that the rails situated between two pairs of wheels complete the electric circuit. This circuit moves along with the motor-car, which also carries the source of current, and the amount of current flowing through the circuit is directly under the control of the driver. The track-rails in front and rear of the car are at all times free from current which is confined to that part of the track between the driving-wheels. The author claims that the tractive force can be increased by this system nearly two hundred per cent, and the motor can be made capable of propelling itself with ease up a forty-per-cent grade.

Origin of Bright's Disease.—The cause of Bright's disease, according to Dr. J. Milner Fothergill, is a tendency of the system to revert to the excretion of solid uric acid, after the manner of the cold-blooded animals and birds, instead of the soluble urea, which is the characteristic excretion of the higher animals. When the uric-acid formation is established, the substance is either gradually deposited in the body—in the articular cartilages by preference—or is cast out by the kidneys, with irritation of those organs. With this effect are often associated "insufficient" liver and migrainous neurotic affections which are growing more common among town populations. "With an insufficient liver, a meat dietary, and insufficient oxidation, the town dweller is the subject, more than all others, of the uric-acid formation, with all its varied consequences. . . . The effect of town life is to produce a distinct retrogression to a smaller, darker, precocious race of less potentialities than the rustic population. Precocity is seen in early puberty, but reproduction is impaired. . . . The retrocedent race perishes either by sterility in the females, or their sparse progeny succumb to the diseases of childhood. . . . This retrocedent race are the possessors of congenitally insufficient livers, and as a consequence are the victims of the uric-acid formation." And Bright's disease is especially their disease.

Plants with Insect-guards.—W. J. Beale and C. E. St. John presented, in the American Association, a study of the hairs in *Silphium perfoliatum* and *Depsocus lacinotus* in relation to insects. The upper surface of the leaf in these plants, near the apex, is thickly set with small hairs, all of which point toward the tip. Similar hairs were found all along the mid-veins, side-veins, and veinlets of the upper surfaces of the leaf. The cavities formed by the perfoliate leaves are very small and hold but little water. They are very full after any rain or heavy dew. These cups do not seem to serve any purpose as insect-catchers, as only a few insects were caught during two weeks in which the plants were watched, and they could afford but little nutrition. It seems more probable to the authors that the object of the cups with their water is to protect the plant from crawling insects, and this is done most effectually.

His own Publisher.—Mr. Ruskin has adopted a plan of his own for producing his books. He is his own publisher, having simply an agent to attend to the business, who works for a commission, and charges fixed prices for books sold, to all buyers alike. His "Establishment" is, as the angry booksellers once contemptuously asserted, "in the middle of a country field"—that is, in a retired country house, "Sunnyside," at Orpington. At first, he would allow of no discount or abatement to the trade, but charged them the same as private purchasers, expecting them to add their profit openly. This set the booksellers against him, and they refused to handle his works. The public, nevertheless, found him out, came to him and bought his books, and he enjoyed a good income and a growing business in spite of his violation of all the accepted rules of the trade. Latterly, he has relaxed his rule, in consequence of representations made to him from every side, and allowed the trade a discount of from ten to fifteen per cent; so that now the larger part of his business is done through the shops. He also set his head against advertising, and has consequently been boycotted by the press, and made the victim of a "complete conspiracy of silence" during the last fifteen years. The "Times" is glad to publish his stray letters now and then, but ignores his books; and the professed literary journals "have not noticed anything that one of the foremost literary men of the time has written since 1872. The secret of Mr. Ruskin's success in spite of his hostility is told by his publishing agent: "In the long run a good article is sure to fetch a good price. Mr. Ruskin is a good writer, and the public has found out the fact. As for my own part, I have simply had to see that the 'get up' was correspondingly good."

How to take a Turkish Bath.—Persons who are timid about taking the Turkish bath, or are afraid of exposing themselves to extremes of temperature, may find security in observing a few simple rules. The bather should first go to a room a little above blood-heat, and remain there until the surface of the body is moist and reddened. If the skin does not begin to assume this condition in about ten minutes, he should have himself given a warm-water-and-towel rubbing. When perspiration has fairly begun, and the skin is moist from head to foot, the bather should have a little cold water thrown upon the feet and legs, and should afterward go into a room of somewhat higher temperature, where he should lie or sit down, with his eyes closed, if that is agreeable. But he should not remain in any of the hot rooms longer than half an hour, nor so long if the ventilation is imperfect or the air impure. He should be "finished" with an affusion of slightly cold water, and should exercise extreme caution about taking the douche or plunge, which it is always safe to omit. He may drink water, soda-water, or lemonade in the bath, and a small cup of coffee or tea in the cooling-room, where he should lie or sit down, wrapped in towels, until the perspiration has subsided; but should not remain so long as to become cold. He should afterward dry the skin briskly with a rough towel, and dress quickly. A short, pleasant walk, followed by a light meal with agreeable conversation and cheerful surroundings, are desirable after the bath.

Roundabout Heating.—We often hear of devices by which the application of force is to be greatly simplified and cheapened; a favorite scheme of the present time is to make the application in the shape of electricity. The projectors of such schemes forget or do not know that the effect they desire to produce must be obtained from the consumption of force in some other form equivalent to the power they will develop, with a considerable excess that is destined to go to waste. The real working of these devices is illustrated by Professor W. M. Williams in the case of a proposed foot-warmer for railway-cars, which is to be heated by applying the electric current to acetate of soda. The foot-warmers of this substance already in use are heated by immersing them in hot water, when they may be kept warm for several hours. "Instead of such direct heating, we are first to heat a boiler, losing heat in the production of steam, losing more in working the steam-engine, very much more in the dynamo, and more again in transmission. The cost of such electric heating would be at least twenty times as great as direct heating, not to mention cost of apparatus."

Oral and Text-Book Instruction.—The difference between the oral and the so-called text-book method has been defined by Dr. William T. Harris in a paper on the "Teaching of Natural Science in the Public Schools," which is published in Bardeen's "School-Room Classics." In the oral method the teacher is the general source of information; in the other, the pupil is sent to the text-book. In neither is cramming with mere words considered good teaching; and yet, with a poor teacher, it may happen under either. The excellence of the oral method should be its freedom from stiffness and pedantry, and its drawing out of the pupil to self-activity in a natural manner. Its abuse happens when the subject is presented in a confused manner, or scientific precision is lost by using too familiar language or by too much pouring-in without exercising the pupil by making him do the reciting and explanation. The excellence of the text-book method consists in getting the pupil to work instead of working for him; in teaching him how to study for himself, and to overcome difficulties by himself, instead of solving them for him. Unless the teacher knows this and directs all his efforts to achieve this end, very great abuses creep in. Thus it may happen that the teacher requires the pupil merely to memorize the words of the book, and does not insist upon any clear understanding of it. Indolent teachers lean upon the text-book and neglect to perform their own part of the recitation. But in the hands of the good teacher the text-book is a powerful instrument to secure industry, precision, accuracy, and self-help on the part of the pupil.

NOTES.

The theories expressed in the "Monthly" by Mr. Eaton and Mr. Gouinlock, that constriction of the blood-vessels of the head by tight hats is a chief cause of baldness, have been reviewed by Professor T. Wesley Mills, who only partly accepts them, and holds that the principal root of the trouble is in nervous strain. Men, by their position and more intense responsibilities, are more liable to this disorder than women, because they are more subject to mental overwork. "Baldness," this author concludes, "is one more of the many warnings of our day—one of Nature's protests against the irregular and excessive activity maintained in this restless age."

"There is no reasonable doubt," says J. L. Kaine, of Milwaukee, in a paper on the "Condition of Health in Cities," "that if the public would apply such laws as sanitarians are agreed about, there would be an immense saving in human life and in the time and money now lost through sickness. The conditions of health in cities involve only fresh air and wholesome water. Given these, which a man can not provide for himself, and given the exercise of some control over the character of the food-supply, a man can take care of other conditions himself—he can keep a clean skin and be temperate and take exercise."

The Medico-Legal Society of New York offers the Elliott F. Shepard prize of $100 for the best essay on any subject within the domain of medical jurisprudence or forensic medicine, with second and third prizes of $75 and $50, respectively, for the next best essays. The competition is open to all students in the subject throughout the world, upon the condition of their becoming members of the society. It will close on the 1st of April, 1888. Papers designed for it should be sent to the president of the society, New York.

Monotonous, continuous sounds are recommended by various persons as promotive of sleep. Any one who has experienced the murmur of the insect and leaf life of a forest knows how quieting it is. So the purling of the waters, the humming of a hive of bees, the buzz of a spinning-wheel, and the murmur of a distant factory, all act as lullabies. And Mr. S. N. Stewart asserts in the "Scientific American" that there is no better sleep-guard than machinery. A person having a spring or electric or water motor to run her sewing-machine need only remove the needle, place the machine near the patient, and let it run.

The new work by Dr. Charles Mercier on the "Nervous System and the Mind," which is intended to serve as an introduction to the "Scientific Study of Insanity," will contain an exposition of the new neurology as founded by Herbert Spencer and developed by Hughlings Jackson; an account of the constitution of the mind from the evolutionary stand-point, showing the ways in which it is liable to be disordered; and a statement of the connection between nervous function and mental processes as thus regarded.

A band of forgers of Swiss lake-dwelling antiquities have been detected and brought to trial, who appear to have been carrying on a quite extensive business. Among their deceptions was the installation of a spurious "horn age," which they effected by rudely carving objects of horn and planting them where they would afterward be excavated.

Dr. Albert E. Leeds, in the American Association, after referring to the rapid pollution which local water-supplies are undergoing in consequence of the growth of manufacturing towns, described what he called the "American System of Water Purification." It 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, with cleansing by mechanical means.

M. Hilt, director of the coal-mines of La Wurm, near Aix-la-Chapelle, has devised a way for keeping the galleries clear from fire-damp by establishing a system of piping, through which the gas is sucked away into a reservoir. It can then be prepared and applied to any use for which carbureted hydrogen is suitable.

The amount expended by the British people on alcohol appears to be diminishing with considerable regularity. The total for 1886 was £122,905,785, against £123,258,-906 in 1885, and £146,288,759, the highest expenditure, in 1876. The diminished amount drunk is, however, still enormous, and it is worthy of remark that it is drunk by a diminishing number of persons, for the number who abstain totally, or drink exceedingly little, is steadily increasing.

The efficiency of oil, when dropped on the water, to calm boisterous waves may now be regarded as established. It is astonishing how small a quantity of oil will answer the purpose. Admiral Cloné gives the amount as from two to three quarts an hour dropped from perforated bags hanging over the sides of the ship in positions varying with the wind. The oil, then, by its own outspreading, extending over the waves, forms a film of less than a two and a half millionth part of an inch in thickness; and this is enough to reduce breaking waves and dangerous "rollers" to unbroken undulations that are practically harmless. The oils that have been found most effective are seal, porpoise, and fish oils. Mineral oils, such as are used for illumination, are too light; but the lubricating oils are denser, and may be found sufficient.

Mr. J. Norman Lockyer, in his "Chemistry of the Sun," states his theory of dissociation by saying that "chemists regard matter as composed of atoms and molecules. The view now brought forward simply expands this series into a larger number of terms, and suggests that the molecular grouping of a chemical substance may be simplified almost without limit if the temperature be increased."

OBITUARY NOTES.

Sir Julius von Haast, whose name is closely associated with the record of geographical and geological investigation in New Zealand, died August 16th, in the sixty-eighth year of his age. He was a native of Bonn, Germany, and a student at its university. He was commissioned by an English company to go to New Zealand for the purpose of showing its suitability for German elements; and having arrived there in 1858, devoted the larger part of the rest of his life to scientific exploration. The results of this work are given in his "Geology of the Provinces of Canterbury and Westland," and in many papers in English scientific societies on the geology and physical geography of the islands. He discovered the Grey and Buller coal-fields, and several gold-bearing districts; instituted the Canterbury Museum, the first museum in the southern hemisphere, which has more than one hundred and fifty thousand labeled specimens, and founded the Philosophical Institute of Canterbury.

Gustav Theodor Fechner, Professor of Experimental Physics at the University of Leipsic, has recently died, in the eighty-seventh year of his age. He was best known by his work on psycho-physics, or the law of relation between the intensity of the stimulus and that of the resulting sensation, which he begun when he was nearly sixty years old, and which has become the center of a considerable literature. He was also active for many years in other branches of science, and was the author of a book of poems and a book of riddles.

Professor Balfour Stewart, Professor of Physics and Director of the Physical Laboratory in Owen's College, Manchester, England, died a few days before Christmas, in the fifty-eighth year of his age. He made his first start in commercial life, but soon turned his attention to science. His first scientific papers were published in the "Transactions" of the Royal Society of Victoria. He studied, experimentally, the radiation and absorption of heat, and for his labors received the Rumford medal in 1868. As director, for about ten years, of the Kew Observatory, he established the instruments for the self-registration of the direction and intensity of magnetic force. He was much interested in psychical research. Besides his "Elementary Practical Physics," and other properly scientific publications, he was the author of the curious books, "The Unseen Universe," and "Paradoxical Philosophy."

Herr August Kappler, from whose sketches of Dutch Guiana we have extracted an account of the monkeys of the country, recently died at Stuttgart, aged seventy-one years.

Professor Charles L. Bloxam, Professor of Chemistry in King's College, London, died November 28th, in the fifty-sixth year of his age. He was distinguished in technical and analytical chemistry, and as the author of several hand-books of chemistry and metallurgy, and of an excellent text-book of chemistry.

Dr. E. Baltzer, Professor of Mathematics in the University of Giessen, died November 7th, in the seventieth year of his age.

HENRY BRADFORD NASON

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THE ECONOMIC OUTLOOK—PRESENT AND PROSPECTIVE.

By Hon. DAVID A. WELLS.

ECONOMIC DISTURBANCE SERIES, No. VIII.

PART II.

THE causes of the almost universal discontent of labor, which has characterized the recent transitions in the world's methods of production and distribution, and which, intensified by such transitions, have been more productive of disturbances than at any former period, (for, as previously shown, there are really no new factors concerned in the experiences under consideration), would seem to be mainly these :

1. *The displacement or supplanting of labor through more economical and effective methods of production and distribution.*

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

3. *The increase in intelligence, or general information, on the part of the masses, in all civilized countries.*

To a review of the character and influence of these several causes, separately and in detail, attention is next invited.

And, *first*, as to the extent and influence of the displacement of labor through more economic and effective methods of production and distribution. Of the injury thus occasioned, and of the suffering attendant, no more pitiful and instructive example of recent date could be given, than the following account, furnished to the United States Department of State,* of the effect of the displacement of hand-loom weaving in the city of Chemnitz, Saxony, by the introduction and use of the power-loom :

* Report of United States Consul George C. Tanner, Chemnitz, December, 1886.

In 1875 there were no less than 4,519 of the so-called "*master-weavers*" in Chemnitz, each of whom employed from one to ten journeymen at hand-loom weaving in their own houses. The introduction of machinery, however, imposed conditions upon these weavers which they found the more difficult to meet the more the machinery was improved. The plainer goods were made on power-looms, and work in the factories was found to be more remunerative. Instead of giving work to others, they were gradually compelled to seek work for themselves. The independent "master" soon fell into ranks with the dependent factory-hand, but as he grew older and his eyesight failed him he was replaced by younger and more active hands, and what once promised to become a well-to-do citizen in his old age now bids fair to become a burden upon the community. Those who had means of procuring the newer Jacquard contrivance, or even the improved "leaf" or "shaft-looms," managed to eke out a subsistence; but the prospects of the weavers who have learned to work only with the hand-looms are becoming more hopeless every day.

Now, while such cases of displacement of labor appeal most strongly to human sympathy, and pre-eminently constitute a field for individual or societary action for the purpose of relief, it should be at the same time remembered that the world, especially during the last century, has had a large experience in such matters, and that the following points may be regarded as established beyond the possibility of contravention: 1. That such phases of human suffering are now, always have been, and undoubtedly always will be, the inevitable concomitants of the progress of civilization, or the transitions of the life of society to a higher and better stage. They seem to be in the nature of "growing-pains," or of penalty which Nature exacts at the outset, but for once only, whenever mankind subordinates her forces in greater degree to its own will and uses. 2. That it is not within the power of statute enactment to arrest such transitions, even when a large and immediate amount of human suffering can certainly be predicated as their consequent, except so far as it initiates and favors a return of society toward barbarism; for the whole progress in civilization consists in accomplishing greater or better results with the same or lesser effort, physical or mental. 3. All experience shows that, whatever of disadvantage or detriment the introduction and use of new and improved instrumentalities or methods of production and distribution may temporarily entail on individuals or classes, the ultimate result is always an almost immeasurable degree of increased good to mankind in general. In illustration and proof of this, attention is asked to the following selection from the record of a great number of well-ascertained and pertinent experiences:

The invention of the various machines which culminated in the knitting or weaving of stockings by machinery in place of by hand, occasioned great disturbances about the commencement of the present century among a large body of operatives in the counties of Leicester and Nottingham, in England, who had been educated to old methods of stocking-making and were dependent upon the continued prosecution of them for their immediate livelihood. The new stocking-frames as they were introduced were accordingly destroyed by the handicraft workmen as opportunity favored (over one thousand in a single burst of popular fury), houses were burned, the inventors were threatened and obliged to fly for their lives, and order was not finally restored until the military had been called out and the leading rioters had been arrested and either hanged or transported. Looking back over the many years that have elapsed since this special labor disturbance (one of the most notable in history), the first impulse is to wonder at and condemn what now seems to have been extraordinary folly and wrong on the part of the masses, in attempting to prevent by acts of violence the supersedure of manual labor engaged in making stockings through the introduction and use of ingenious stocking-making machinery. But, on the other hand, when one remembers the number of persons who, with very limited opportunity for any diversity of their industry, and with the low social and mental development incident to the period, found themselves all at once and through no fault of their own deprived of the means of subsistence for themselves and their families, and are further told by the historian of the period * that, from the hunger and misery entailed by this whole series of events, the larger portion of fifty thousand English stocking-knitters and their families did not fully emerge during the next forty years, there is a good deal to be set down to and pardoned on account of average human nature. The ultimate result of the change in the method of making stockings and its accompanying suffering has, however, unquestionably been that for every one person poorly fed, poorly paid, badly clothed, and miserably housed, who at the commencement of the present century was engaged in making stockings on hand-looms or in preparing the materials out of which stockings could be made, ten at least are probably now so employed for a third less number of hours per week, at from three to seven times greater average wages, and living under conditions of comfort that their predecessors could hardly have even anticipated.†

In strong contrast also with the report of the pitiful distress of the displaced hand-loom weavers of Saxony comes this other statement from many sources: That in all the great manufacturing centers of Germany, and especially in the cities of Chemnitz (where the hand-looms are being rapidly displaced), in Crefeld, Essen, and in Düssel-

* "History of the Machine-wrought Hosiery Manufactures," by William Felkin, Cambridge, England, 1867.

† The wages of the stocking-knitters in Leicestershire in the early years of this century were among the very lowest paid in any branch of industry in Great Britain, and did not exceed on an average six shillings a week. In 1880 the wages paid first-class operatives (men) in the hosiery-factory of the late A. T. Stewart, at Nottingham, England, were 44*s.* 5*d.* per week, and for girls of similar capabilities 16*s.* 6*d.* Within more recent years further improvements in machinery, by creating a disproportion between the supply of the labor of framework-knitters and the demand for it, has again greatly disturbed the condition of the work-people in this branch of industry in England.

dorf, the standard of living and of comfort among the masses is far higher than at any former period. Writing from Mayence under date of January, 1887, United States Commercial Agent J. H. Smith reports that, "although business is in an unsatisfactory state, it does not seem to affect the workingman greatly. Wages remain pretty much the same, and few discharges of hands take place. The stagnant state of the market only serves to make the necessaries of life cheaper, and to enhance the purchasing power of the laborer's money." United States Consul-General Raine, at Berlin, during the same month, also reported that "wages in Germany show a rising tendency"; that workingmen with permanent work, and wages unchanged, are deriving marked advantages from the low prices of provisions; and that, although the population of Germany has experienced an increase of three millions since 1879, "no lack of work was noticeable."

The readiness with which society comprehends the suffering contingent on the relentless displacement of labor by more economical and effective methods of production and distribution, and the overmastering feelings of sympathy for individual distress thereby occasioned, causes it to generally overlook another exceedingly interesting and important involved factor, and that is the relentless impartiality with which the destructive influences of material progress coincidently affect capital (property) as well as labor. It seems to be in the nature of a natural law that no advanced stage of civilization can be reached except at the expense of destroying in a greater or less degree the value of the instrumentalities by which all previous attainments have been effected. Society proffers its highest honors and rewards to its inventors and discoverers; but, as a matter of fact, what each inventor or discoverer is unconsciously trying to do is to destroy property, and his measure of success and reward is always proportioned to the degree to which he effects such destruction. If to-morrow it should be announced that some one had so improved the machinery of cotton-manufacture that ten per cent more of fiber could be spun and woven in a given time with no greater, or a less expenditure of labor and capital than heretofore, all the existing machinery in all the cotton-mills of the world, representing an investment of millions upon millions of dollars, would be worth little more than so much old iron, steel, and copper; and the man who should endeavor to resist that change would, in face of the fierce competition of the world, soon find himself bankrupt and without capital. In short, all material progress is effected by a displacement of capital equally with that of labor; and nothing marks the rate of such progress more clearly than the rapidity with which such displacements occur. There is, however, this difference between the two factors involved. Labor displaced, as a condition of progress, will be eventually absorbed in other occupations; but capital displaced, in the sense of substituting the new for what is old, is practically destroyed.

It has previously been pointed out that the great and signal result of the recent extraordinary material progress, has been to increase the abundance and reduce the price of most useful and desirable commodities. But this statement applies to capital, as a commodity, in common with other commodities ; and here comes in another very significant and, from a humanitarian point of view, a most important result, or perhaps rather a "law" (pointed out years ago by Bastiat, and in proof of which evidence will be presently submitted), that, "in proportion to the increase of capital, the relative share of the total product falling to the capitalist is diminished, while, on the contrary, the laborer's share is relatively increased. At the same time all progress, from scarcity to abundance, tends to increase also the absolute share of product to both capitalist and laborer, inasmuch as there is more to divide."

Again, it is a singular anomaly, that while an increasing cost of labor has been the greatest stimulant to the invention and introduction of labor-saving machinery, labor employed in connection with such machinery generally commands a better price than it was able to do when similar results were effected by more imperfect and less economical methods. Perhaps the most remarkable illustration of this is to be found in the experience of the American manufacture of flint-glass, in which a reduction, since 1870, of from 70 to 80 per cent in the market price of such articles of glass table-ware as goblets, tumblers, wine-glasses, bowls, lamps, and the like, consequent upon the adoption of methods greatly economizing labor and improving quality, has been accompanied by an increase of from 70 to 100 per cent in wages, with a considerable reduction in the hours of labor.* M. Poulin, a leading French manufacturer at Rheims, has recently stated that the results of investigations in France show that during this century the progress of wages and machinery has been similar—the wages in French wool-manufactories, which were $1\frac{1}{2}$ franc per day in 1816, being (in 1883) 5 francs ; while the cost of weaving a meter of merino cloth, which was then 16 francs, is now 1*f.* 45*c.* "In Nottingham," says Mr. Edwin Chadwick, the distinguished English economist,† "the introduction of more complex and more costly machinery for the manufacture of lace, while economizing labor, augmented wages to the extent of over 100 per cent. I asked a manufacturer of lace whether the large machine could not be worked at the common lower wages by any of the workers of the old machine. 'Yes, it might,' was the answer, 'but the capital invested in the new machinery is very large, and if from drunkenness or misconduct anything happened to the machine, the consequences would be very serious.' Instead of taking a man out of the streets, as might

* "Report on the Statistics of Wages," by Joseph D. Weeks, "Tenth Census of the United States," vol. xx.

† "Employers' Liability for Accidents to Work-people," by Edwin Chadwick.

be done with the low-priced machine, he (the employer) found it necessary to go abroad and look for one of better condition, and for such a one high wages must be given."

A remarkable exhibit made in the annual reports of the Illinois Central Railroad, showing the cost of the locomotive service for each year for the past thirty years, is also especially worthy of attention in connection with this subject. From this it appears that the cost per mile run has fallen from 26·52 cents in 1857 to 13·93 cents in 1886; a reduction which has been effected wholly by inventions and improvements in machinery. But a further point of greater interest is, that during this same period the wages of the engineers and firemen have risen from 4·51 cents to 5·52 cents per mile run; or, in other words, the engineers and firemen on the Illinois Central, who in 1857 received 17 per cent of the entire cost of its locomotive service, received in 1886 nearly 40 per cent (39·6) of the total cost.

The introduction of machinery in many branches of industry—and more especially in agriculture—while increasing, perhaps, the monotony of employment, has also greatly lightened the severity of toil, and in not a few instances has done away with certain forms of labor which were unquestionably brutalizing and degrading, or physically injurious.*

Another paradox which should not be overlooked in this discussion is, that those countries in which labor-saving machinery has been most extensively adopted, and where it might naturally be inferred that population through the displacement and economizing of labor would diminish, or at least not increase, are the very ones in which population has at the same time increased most rapidly.

Taking all the machinery-using countries into account, the number of persons who have been displaced during recent years by new and more effective methods of production and distribution, and have thereby been deprived of occupation and have suffered, does not appear to have been so great as is popularly supposed; a conclusion that finds support in the fact that, notwithstanding trade generally throughout the world has been notably depressed since 1873, through a continued decline in prices, reduction of profits, and depreciation of property, the volume of trade—or the number of things produced, moved, sold, and consumed—on which the majority of those who are the recipients of wages and salaries depend for occupation, has all this time continually increased, and in the aggregate has probably been little if any less than it would have been if the times had been

* Mowing, reaping, raking machinery, winnowing, shelling, and weighing machines, hay-tedders, horse-forks, wheel-harrows, improved plows, better cultivators, and so on through almost the entire list of farm-tools, have combined to make the change in farm-work almost a revolution; and those only who have spent years in farming by old methods can fully realize the extent to which the severity of toil has been lightened to the farmer by the introduction and use of machinery.

considered prosperous. In the United States there is little evidence thus far that labor has been disturbed or depressed to any great extent from this cause. But there is undoubtedly a feeling of apprehension among the masses that the opportunities for employment through various causes—continued large immigration, absorption of the public lands, as well as machinery improvements—are less favorable than formerly, and tend to be still further restricted ; and this apprehension finds expression in opposition to Chinese immigration, to the importation of foreign labor on contract, to the increase in the number of apprentices, and in the endeavor to restrict the participation in various employments to membership of certain societies. The reports from many of the large industrial centers of the United States during the past year (1887) have been to the effect, that while specific results are now attained at much less cost and with the employment of much less labor, the increased demand, owing to a reduction in the price and improvement in the quality of the articles manufactured under the new conditions, has operated not merely to prevent any material reduction in the rates of wages, or in the number of employés, but to largely increase both rates and numbers. The annual investigation made by the managers of "Bradstreet's Journal" into the condition of the industries of the country for 1887, indicated that in March of that year 400,000 more industrial employés were at work than in 1885. In thirty-three cities the number of employés at work was 992,000 by the census of 1880, 1,146,000 in January, 1885, and 1,450,000 in March, 1887. The change in the average wages received between 1885–'87 as compared with 1882–'85, shows a very general increase : from 10 to 15 per cent in woolen goods and clothing ; 15 in cotton goods, silk goods, and iron-mills ; 12 per cent in the wages of three fourths of the employés of beef- and pork-packing establishments ; 20 per cent in anthracite-coal mining, and the like. In the case of the boot and shoe industry, an opinion expressed by those competent to judge is, that while "there has been a reduction in cost and in the number of employés per 100 cases produced of from 15 to 20 per cent, the actual number of persons employed has been increased ; and in cases where the wages of old classes of workmen are affected they have been raised."

On the Continent of Europe, the grievances of labor attributable to new conditions of production and distribution seem to be mainly confined to the agriculturists and to those bred to handicraft employments ; and for both of these classes the outlook is not promising.

In Great Britain the number of persons who are in want, for lack of employment, appears to have largely increased in recent years.*

* "The one thing which I, and those associated with me, always at once peremptorily refuse to do," said recently an English (London) clergyman whose life is among the poor, "is to try and get men, women, and children work to do. I say at once: 'That is impossible. To get you work would be to deprive some other one of work, and that I can not

But as there has been no cessation in the growth of the mechanical industries of the United Kingdom, or in her transportation service by land or sea, or in her production of coal and iron, or in the consumption of her staple food commodities—such growth, although not increasing as it were by "leaps and bounds," as in some former periods (as during the decade from 1865 to 1875), being always in a greater ratio than her increase in population *—it would seem that any increase in the number of her necessarily unemployed must have been mainly derived from the one branch of her industry that has not been prosperous, namely, agriculture, in which the losses in recent years on the part alike of landlords, tenants, and farm-laborers, from decline in land and rental values, in the prices of farm products, and through reduction of wages, has been very great.† Mr. Alfred Russel Wallace inclines to the opinion that twenty thousand English farm-laborers, involving, with their families, a population of from sixty to eighty thousand, were, between 1873 and 1887, obliged to quit their homes, and mostly drifted to the larger cities, in consequence merely of substituting, through the increasing unprofitableness of grain-culture, pasture for arable land; and this substitution is reported as at present continuing at the rate of two hundred and sixty thousand acres per annum.

We have in these facts, furthermore, a clew to the cause of the increased discontent in recent years in Ireland. If the Irish tenantry could pay the rent demanded by the landlords, and at the same time achieve for themselves a comfortable subsistence, there would be no necessity for extraordinary governmental interference on their behalf; and this was what, prior to the years 1873–'75, the prices of farm products—especially of all dairy products—enabled the better class

do,'" the meaning of which was that every occupation in London, in the opinion of the speaker, was full.

* The ratio of increase in the population of the United Kingdom between 1875 and 1885 was about 10 per cent. During the same period the increase in the production of coal was 20 per cent; in pig-iron, 16 per cent; in railway receipts from goods-traffic per head of population, 18 per cent; in shipping engaged in foreign trade, 33 per cent; in consumption of tea per head, 13½ per cent; in sugar per head, 19 per cent.

† "The agricultural returns for Great Britain tell us that, from 1873 to 1884, the quantity of arable land in the country has decreased considerably more than a million acres. The reason of this is chiefly that landlords having farms thrown on their hands, and being unable to obtain fresh tenants, find it the most economical method to lay down the land in permanent pasture, which requires the minimum of labor, superintendence, and expenditure to work. This in part explains the forced exodus of the agricultural laborers no longer required to cultivate the land thus laid down. About twenty-five laborers are required on an arable farm of one thousand acres, while probably five would be ample on the same quantity of pasture; and we should have a diminution of twenty thousand laborers from the change of cultivation which has taken place, or, with their families, a population of sixty or eighty thousand, which, from this cause alone, have been obliged to quit their homes, and have mostly drifted hopelessly to the great towns." In addition, a large number of farms "are now, and have been for some years, lying absolutely waste and uncultivated."—*Bad Times*, Alfred Russel Wallace, London, 1885.

of Irish tenants to achieve. But since then, the fall of prices has entirely changed the condition of affairs and made a reduction and perhaps an entire abolition of the rents of arable land in Ireland an essential, if the Irish tenant is to receive anything in return for his labor. A French economist—M. de Grancey—who has recently published the results of a study of Ireland, founded on a personal investigation of the country, is of the opinion that, although the population of the island has been reduced by emigration from 8,025,000 in 1847 to 4,852,000 in 1887, it is not now capable of supporting in decency and comfort more than from two to three million inhabitants. The same authority tells us that agricultural distress, occasioned by the same agencies, exists to-day in France, in as great a degree as in Great Britain. The peasant proprietors have ceased to buy land and are anxious to sell it ; and in the department of Aisne, one of the richest in France, one tenth of the land is abandoned, because it is found that, at present prices, the sale of produce does not cover the expenses of cultivation.*

Now, if it were desirable to search out and determine the primary responsibility for the recent large increase in the number of the English unemployed, or for the distress and revolt of the Irish tenantry, or the growing impoverishment of the French and German peasant proprietors, it would be found that it was not so much the land and rent policy of these different countries that should be called to account, as the farmers on the cheap and fertile lands of the American Northwest, the inventors of their cost-reducing agricultural machinery, of the steel rail, and of the compound marine engine, which, collectively, have made it both possible and profitable "to send the produce of five acres of wheat from Chicago to Liverpool for less than the cost of manuring one acre in England." And, looking into this matter from a cosmopolitan point of view, and balancing the aggregate of good and bad results, how small are the evils which have been entailed upon the agricultural laborers in England, Ireland, or elsewhere, in consequence of changes in the condition of their labor, in comparison with the almost incalculable benefits that have come, in recent years, to the masses of all civilized countries, through the increased abundance and cheapness of food, and a consequent increase in their comfort and vitality !

Another matter vital to this discussion may here and next be properly taken into consideration. As the evidence is conclusive that the direct effect of material progress is to greatly increase and cheapen production and to economize labor ; and as there is no reason to sup-

* M. de Grancey is of the opinion that one of the most fertile sources of Irish misery and degradation is the unauthorized and illegal subletting of farms. He states that he met with cases where from forty-five to fifty persons lived in a state of semi-starvation on a farm calculated to yield a comfortable subsistence to a family of five or six. In each generation, the farm, in despite of special prohibitory clauses in the lease, is divided among the sons. Where there are no sons, subtenants are found willing to take small parcels of land at the most exorbitant prices.

pose that the maximum of progress in this direction has been attained, and every reason to expect that the future will be characterized by like and even greater results progressively occurring, the question arises, Is labor to be continually, and in a degree ultimately displaced from occupation by progressive economy of production? Is continual and fiercer competition to effect sales, both of product and labor, in excess of current demands, likely to produce continued disturbance and an unhealthy fall of prices, extensive reductions in wages, and the more extensive employment of the cheaper labor of women and children? Is society working through all this movement toward what has been called an "anarchy of production"?

Experience thus far, under what may be termed the new *régime* of production and distribution, does not, however, fairly warrant any such anticipations. Wages, speaking generally, have not fallen, but have increased; and, except in Germany, there is little indication of a tendency to increase the hours of labor, or encroach upon the reservation of Sunday. Everywhere else, even in Russia, the tendency is in the opposite direction.

Again, the extent and rapidity of the increase in the consumption of all useful and desirable commodities and services which follows every increase in the ability of the masses to consume, is one of the most wonderful of modern economic phenomena; and the one thing which, more than any other, augments their *ability* to consume, is the reduction in the price of commodities, or rather the reduction in the amount of human effort or toil requisite to obtain them, which the recent improvements in the work of production and distribution have effected. Better living, contingent on a reduction of effort necessary to insure a comfortable subsistence, induces familiarity with better things; constitutes the surest foundation for the elevation of the standard of popular intelligence and culture, and creates an increasing desire for not only more but for a higher grade of commodities and services. There are, therefore, two lines upon which the consumption of the products of labor is advancing: the one, in which this stimulant is animal in its nature, and demands food, clothing, shelter, and fuel, for its satisfaction; and the other intellectual, which will only be satisfied by an increased supply of those things which will minister to a higher standard of comfort and education. Thus far the world's manual laborers have not kept up in culture with the improved and quickened methods of production; and therefore in certain departments there is not yet that opportunity for work that there undoubtedly will be in the future.

"There is no good reason why a workingman earning one thousand or fifteen hundred dollars a year, as many do, should not desire as many comforts in the shape of furniture, books, clothing, pictures, and the like for himself and his family, and desire them as intelligently, as the minister, or lawyer, or doctor who is earning a similar amount."

But as abstract conclusions in economic as well as in all other discussions are best substantiated and comprehended through practical examples, to examples let us turn. And first as to certain notable instances derived from recent experiences, showing how remarkably and rapidly increase of consumption has followed reduction of prices, even in cases where the reduction has been comparatively slight, and a marked increase of consumption could not have been reasonably anticipated.

Among the staple food articles that have greatly declined in price during recent years is sugar, and this decline has been attended with a large increase in consumption; the decline in the average price of fair refining sugar in the United States (in bond) having been from 4·75 cents per pound in 1882 to 2·92 cents in 1886; while the average consumption per capita, which was 39 pounds for the five years from 1877 to 1882, was 49·8 pounds for the five years from 1882 to 1887. Comparing 1885 with 1887, the consumption of sugar in the United States increased over 11 per cent, or largely in excess of any concurrent growth of population. Converting, now, so much of this larger consumption as was due to diminished price (probably more than one hundred million pounds) into terms of acres and labor employed in its production; into the ships and men required for its transportation; into the products, agricultural and manufactured, and the labor they represent, that were given in exchange for it, and we can form some idea of the greater opportunities for labor through larger volume of exchanges, and the increased comfort for those who labor, that follows every reduction in the cost necessary to procure desirable things.

In 1887, with an import price of about 16 cents per pound, the importation of coffee into the United States was 331,000,000 pounds. In 1885, with an average import price of eight cents, the importation was 572,000,000 pounds. Between 1873 and 1885 the coffee product of the world that went to market, concurrently with this large decline in its price, increased to the extent of 52 per cent.

The great reduction in recent years in the price of copper, consequent upon its increased product and a surplus offering upon the world's markets, led to such an extraordinary increase in the demand for manufactures of copper and brass, and such a general extension of the uses of the metal, as to finally not only absorb any surplus stock, but also to create apprehension of an inadequacy of supply. For the year 1886 the authorities of the United States Geological Survey estimate that the increase in the consumption of copper by the leading American manufactories of copper and brass was in excess of 24 per cent; and that a very nearly equal increase was experienced in the preceding year (1885); all of which indicates a large if not a fully proportional increase for the periods mentioned in the opportunity for labor, at comparatively high wages, in these departments of industry. On the other hand, with a large advance in the price of copper during the latter months of 1887, the operations of the manufacturers of copper and brass were reported as having been materially restricted.

Every reduction in the price of gas has been attended with greatly increased consumption, entailing greater demand for labor in the mining and transporting of coal and other materials, and in service of distribution; and it is very doubtful whether the apprehensions of impairment of the value of the capital of the gas companies, which are always excited by such reductions, are ever, to any disastrous extent, realized; and it is the general experience that the profits on the increased demand created by cheaper supply continue to afford to the gas companies reasonable and often equal returns on their invested capital. It seems to be also well established that the extensive introduction and use of the electric light has in no way impaired the aggregate consumption of gas.

In 1830 the average price of cotton cloth in the United States was about seventeen cents per yard; in 1880 it was seven cents. This reduction of price has been accompanied by an increase in the annual per capita consumption of the people from 5·90 pounds of cloth to 13·91 pounds; which in turn represents a great increase in all the occupations connected with cotton, from its growth to its transformation into cloth and cloth fabrications; and the evidence is conclusive that in all these occupations the share of labor in the progressing augmentations of values and quantities has continually increased; the advance in the wages of the cotton-mill operatives, during the period under consideration, having been fully 80 per cent.

When, through competition, the companies controlling the submarine telegraph lines between the United States and Europe reduced in 1886 their rates from 40 to 12 cents per word, 212 words, it was reported, were regularly transmitted in place of every 100 previously sent. Assuming this report to be correct, a comparison of receipts under the new and old rates would give the following results: 210 words at 12 cents each, $25.20; 100 words at 40 cents each, $40; or a reduction in rates of 70 per cent impaired the revenues of the lines to an extent of only 37 per cent.

A reduction in 1886 in the postal system of the United States of *three* cents in the fee for domestic money-orders not exceeding $5 (or from eight to five cents) has operated to increase the use of this service to the remitters of small sums in a very noticeable degree, the average amount of each order issued in 1887 being but $12.72 as against an average of $14.33 in 1886, and larger sums in previous years; while the increase in the number of money-orders issued in 1887 was 16·27 per cent greater than in 1886. The aggregate value of these orders for 1887 is returned at the large sum of $117,462,000.

The following have been the economic changes within a decade in the business of manufacturing American watches, and the manner in which such changes have affected the welfare alike of owners and employés: "A great reduction in price from which there has been no recovery. Business has invariably, and with scarcely notable friction, adjusted itself to new conditions; and save only in exceptional cases —new companies struggling for a place—the capital invested has been fairly remunerative. Best of all, the wages of operatives have been maintained; for one reason among others, that reductions in rates paid for piece-work have operated to stimulate the intelligence of the workman, so that he devises for his special works methods and appliances which not only increase his speed but his product also, and improve its quality. The great decline in recent years in the price of American watches has not been caused by the importation of foreign watches, but has sprung wholly out of an intense competition between American manufacturers; and from this and other causes the industry has experienced all the vicissitudes incident to the occurrence of what are generally denominated 'hard times.'"

The following examples of the increase in the consumption of commodities, consequent on reductions of price through abatements of taxation, also indicate how largely the opportunities for labor and of the sphere of exchanges or business can be increased in the future by an extension of this policy:

Reductions in the price of tea in Great Britain, following a progressive reduction in the duties on the imports of this commodity, from 2*s.* $2\frac{1}{2}$*d.* in 1852 to 6*d.* (the present rate), have been accompanied by an increase in its annual consumption from 58,000,000 pounds in 1851 to 337,000,000 in 1885, or from 1·9 pound per head of the population to 5 pounds.

A removal in 1883 of the comparatively small tax of one cent on every hundred matches imposed by the United States, is reported to have reduced the price about one half, and to have increased the domestic consumption to the extent of nearly one third.

In 1883 a few additions were made to the free list under the tariff of the United States, and among them were included unground spices, which had been previously subjected to duties, which, although heavy as *ad valorem*, were in themselves so small specifically (as five cents per pound each on pepper, cloves, and pimento) that their influence on the consumption of the American people, with their acknowledged tendency to extravagance, would not have been generally regarded as likely to be considerable; and yet the removal of the duties on these commodities, which pass almost directly into consumption, carried up their importations in the following remarkable manner: In the case of pepper, from 6,973,000 pounds in 1883 to 10,995,000 pounds in 1886; pimento, from 1,283,000 pounds to 2,500,000 pounds; cassia-buds, from 27,739 pounds to 238,000; cloves, from 989,000 pounds to 1,298,000; nutmegs, from 661,132 pounds to 1,189,456; while the importation and consumption of mace in the country more than doubled and that of cayenne pepper more than trebled during the same period. It is evident, therefore, that the masses of the United States during the continuance of these taxes did not have all the spices they would like, to make their food more palatable and savory; that trade between the spice-producing countries and the United States was restricted; and, as all trade is essentially an exchange of product for product, that the labor of the United States gained under the new conditions, either by sharing in the greater abundance of useful things, or through an increased opportunity for labor in producing the increase of commodities that the increase of exchanges demanded.

The original cost of the suspension-bridge between the cities of New York and Brooklyn was $15,000,000, entailing an annual burden of interest at five per cent of $750,000. When first opened to public use in September, 1883, the rates of fare were fixed at five cents per ticket for the cars, and one cent per ticket for foot-passengers, no ticket being sold at any less price by packages. The total receipts for the first year (1883–'84) from all traffic sources were $402,938, and the total number of car and foot passengers was 11,503,440; 5,324,140 of the former and 6,179,300 of the latter. The results of the first year's operations were not, therefore, encouraging as to the ability of the bridge to earn the interest on the cost of its construction. During the second year (1884–'85), the rates of fare remaining the same, the increase in the aggregate number of passengers was comparatively small, or from 11,503,440 to 14,051,630; but in February, 1885, the rates of fare were greatly reduced—i. e., tickets for the cars (when sold in packages of ten) from five cents to two and a half, and tickets for promenade (when bought in packages of twenty-five) from one cent to one fifth of a cent. The results of this reduction immediately showed themselves in a remarkable increase for the year of 71 per cent in the number of car and foot passengers, or from an aggregate of 14,051,630 in 1884–'85 to 25,082,587 in 1885–'86, and this aggregate has gone on increasing to 30,604,726 for the year ending December 1, 1887. Concurrently also the bridge receipts from traffic have increased from $565,544.45 in 1884–'85 (the last year of high fares) to $850,724 for the year ending November 30, 1887, with a net profit on the operations of the year of $495,319, or nearly enough to pay two thirds of the interest on the original investment; or, the result of the bridge operations since the reductions of the rates for its use has been accompanied by an increased passenger movement—car and foot—of 108 per cent, and a gain in receipts of 50 per cent.

A further analysis of the experiences of the New York and Brooklyn Bridge since its construction also reveals some curious tendencies of the American people in respect to consumption and expenditures. During the first year the bridge was open to the public, the number of foot-passengers paying one cent was 6,179,300, and the number of car-passengers paying five cents was 5,324,140. The next year, fares remaining unchanged, the number of foot-passengers declined to 3,679,-

733, and the number of car-passengers increased to 11,951,630. In the third year, with a reduction of foot-fares to one fifth of a cent, the number of foot-passengers declined 440,395, or to an aggregate of 3,239,337; while the number of car-passengers (with a reduction of fare from five to two and a half cents) increased 10,130,957, or to 21,843,250. For the year ending December 1, 1887, the number of foot-passengers further declined 574,929, or to 2,664,413, while the number of car-passengers further increased 8,097,063, or to 27,940,313; or to a total aggregate of 30,604,313. A correct explanation of these curious results may not be possible, but one inference from them that would seem to be warranted is, that when the American people find their pecuniary ability is abundantly sufficient to enable them to satisfy their desire for certain commodities or services, they will disdain to economize; and this idea may find illustration and confirmation in another incident of recent American experience. Thus, when the great decline in the price of sugars occurred in 1883, the American refiners expected that, whatever of increase of consumption might be attendant, would occur mainly in the lower grades of sugar; but, to their surprise, the actual increase was largely in respect to the higher grades. A leading refiner, who, somewhat puzzled at this result, asked one of his workmen for an explanation of it, received the following answer: "I give my wife fifty cents every Monday morning with which to buy sugar for the week for my family, and, as she finds that fifty cents will now buy as many pounds of the white as we once could get of the yellow sugars, she buys the white." A European workman (certainly a Frenchman) would probably have acted differently. He would have taken the same grade as before and got two pounds of additional sweetening for his money; or, more likely, he would have bought the same quantity and quality as before, and saved up the measure of the decline of price in the form of money.

Another explanation of the bridge phenomenon may be that the average American, who is always in a hurry, may think that, with the privilege of riding for two and a half cents, he can not afford the time to avail himself of the privilege of walking for a payment of one fifth of a cent.

Mr. Robert Giffen, in a review of the "Recent Rate of Material Progress in England" (British Association, 1887), recognizes an evident tendency, as that country increases in wealth, for the numbers employed in miscellaneous industries, and in what may be called "incorporeal functions"—that is, as artists, teachers, and others, who minister to taste and comfort in a way that can hardly be called material—to increase disproportionately to those engaged in the production of the great staples; and that, therefore, the production of these latter is not likely to increase as rapidly as heretofore. All of which is equivalent to affirming that, in virtue of natural law, the evils resulting from the displacement of labor, through more economic methods of production by machinery, are being gradually and to a large extent counteracted. No one can doubt that this is the tendency in the United States equally as in England, and it finds one striking illustration in the large number of new products that are demanded, and in the number of occupations that have been greatly enlarged or absolutely created in recent years, in consequence of the change in popular taste, conjoined with popular ability, to incur greater expense in the matter of house-building and house-decoration. Ten or fifteen years ago the amount of fine outside work in building constructions—in brick, terra-cotta, stone, and metal—and on interiors, in the way of painting, paper-hangings, wall-coverings with other materials, fine wood-work, carving, furniture-making, carpet-weaving, draperies for doors and windows, stained glass and mirrors, and improved and elaborate sanitary heating and ventilating apparatus, was but a very small fraction of what is now required. Nothing, furthermore, is more certain than that all these departments of industry are to continue progressively enlarging ; for all achievements in this direction increase taste and culture, and these in turn create new and enlarged spheres for industrial occupation.

How these same influences exert themselves for the extension of the intercommunication of intelligence, with the attendant increased demand for service and materials which represent opportunities for labor, is exemplified in the following postal statistics, the result of recent German investigation : Thus, for the year 1865 it is estimated that the inhabitants of the world exchanged about 2,300,000,000 letters ; in 1873, the aggregate was 3,300,000,000 ; in 1885, including postal-cards, it was 6,257,000,000 ; in 1886, 6,926,000,000, with a larger ratio of increase in the transmission of printed matter, patterns, and other articles ; the whole business giving employment to about 500,000 persons, for more than one half of which number there was probably no requirement for service under conditions existing in 1873. And to this aggregate should be added the increased number required to meet the greater requirements for the machinery and service of larger transportation, and vastly larger consumption of all the material and service incident to correspondence. The experience of the postal service of the United States also shows that, at all those points where a free delivery of letters has been established, the postal revenues have quickly and greatly augmented—another illustration that every increased and cheapened facility for use or consumption brings with it greater demands for service or production.

In view, then, of the undoubted tendency, as abundance or wealth increases, for labor to transfer itself, in no small proportions, from lower to higher grades—from the production of the great staples to occupations that minister to comfort and culture, rather than to subsistence —how impolitic, from the standpoint of labor's interests, seems to be the imposition of high taxes (as in the United States) on the importation of works of art of a high character and large cost, under the assumption that it is desirable to tax all such articles as luxuries, and that it is for the interest of the masses to adopt such a policy! In illustration, let us suppose a man of wealth to purchase and import a costly and beautiful art product. Having obtained it, he rarely finds a compensating return for his expenditure in an exclusive and selfish inspection, but rather in exhibiting it to the public; and the public go away from these exhibitions with such higher tastes and culture as impel them to desire to have in their life-surroundings, as much that is artistic and beautiful—not the work of one, but of many—as their means will allow; even if it be no more than a cheerful chromo-lithograph, a photograph, a carpet or a curtain of novel and attractive design, a piece of elegant furniture, or of bronze, porcelain, or pottery. And to supply the new and miscellaneous industries that are created or enlarged by such desires and demands, labor will be, as it were, constantly drained off from occupations in which improved machinery tends to supplant it, into other spheres of employment in which the conditions and environments are every way elevating, because in them the worker is less of a machine, and the rewards of labor are very much greater.

The phenomena of the overproduction of certain staple commodities, although for the time being often a matter of difficulty and the occasion of serious industrial and commercial disturbances, are also certain, in each specific instance, to sooner or later disappear in virtue of the influence of what may be regarded as economic axioms, namely: that we produce to consume, and that, unless there is perfect reciprocity in consumption, production will not long continue in a disproportionate ratio to consumption; and also that, under continued and marked reduction of prices, consumption will quickly tend to increase and equalize, or accommodate itself to production. Illustrations of the *actual* and *possible* under this head, and of the rapidity with which conditions are reversed and "overproduction" disappears, are most curious and instructive. For example, all authorities in 1885 were agreed that the then existing capacity for manufacturing cotton was greatly in excess of the world's capacity for consumption; the season of 1885–'86 closing with a surplus of nearly 400,000,000 yards on the British market, for which the manufacturers found no demand. Since that date, however, and with no special renewal of business activity in any country except the United States, the world's consumption of cotton fabrics has reached a larger total than ever before, and there are probably at the present time (1888) no more spindles in existence than are necessary to supply the current demands for their products. In the case of sugar, also, an increase in consumption occasioned by low prices, and a notable restriction of production through the same price influences, has reduced an estimated actual surplus of sugar on the world's markets in October, 1885, of 1,042,956 tons, to 568,188 tons in October, 1887, "with a good prospect of all surplus being wiped out by October, 1888." The price of fair refining sugar (in bond, which represents the world's prices) has accordingly advanced from 2·37½ cents per pound in July, 1887, to 3·22 in January, 1888.

The production of very few articles has increased in recent years in a ratio so disproportionate to any increase of the world's population as that of iron, and prices of some standard varieties have touched a lower range than were ever before known. Gloomy apprehensions have accordingly been entertained respecting continued over-production, and its disastrous influence in the future on the involved capital and labor. To comprehend, however, the possibilities for this industry in the future, it is only necessary to have in mind that in 1882 (and the proportions have not probably since varied) the population of the United States and of Europe (398,333,750), comprising less than one fourth of the total population of the world (1,424,686,000), consumed nineteen twentieths of the whole annual production of iron and steel; and that if the population of the world outside of Europe and the United States should increase its annual per capita consumption of iron (which is not now probably in excess of two pounds) to only one half of the average annual per capita consumption of the people of a country as low down in civilization as Russia, the annual demand upon the existing producing capacity of iron would be at once increased to the extent of over six million tons. And, when it is further remembered that civilization is rapidly advancing in many countries, like India, where the present annual consumption of iron per head is very small (2·4 pounds), and that civilization can not progress to any great extent without the extensive use of iron, the possibilities for the enormous extension of the iron industry in the future, and the enlarged sphere of employment of capital and labor in connection therewith, make themselves evident.*

As constituting a further contribution to the study of the so-called

* According to a table presented to the British Iron Trade Association by Mr. Jeans in 1882, and subsequently incorporated in a report submitted by Sir Lowthian Bell to the British Commission "On the Depression of Trade" in 1885 (and from which the above data have been derived), the total consumption of iron in the above year was 20,567,746 tons. Of this aggregate, the United States and the several countries of Europe, with a population at that time of 398,333,750, consumed 19,057,963 tons; the following five countries, namely, the United States, the United Kingdom of Great Britain, France, Germany, and Belgium, with a population of 174,506,935, consuming 16,259,514 tons. The aggregate consumption of iron by the population of all the other countries of the world at that time (assumed to be 1,026,538,820) was estimated at 1,509,783 tons, or, deducting the consumption of the population of the British possessions other than in India (as Australia, etc.), at only 888,298 tons, or 1·96 pound per head per annum. The annual per capita consumption of different countries in 1882 was reported as follows: The United Kingdom, 287 pounds; the United States, 270 pounds; Belgium, 238 pounds; France, 149 pounds; Germany, 123 pounds; Sweden and Norway, 77 pounds; Austrian territories, 37 pounds; Russia, 24·6 pounds; South America and the islands, 13·5 pounds; Egypt, 7·5 pounds; India, 2·4 pounds.

industrial phenomenon of "overproduction," and as illustrating how a greater abundance and cheaper price of desirable commodities, work for the equalization and betterment of the conditions of life among the masses, the recent experience of the article quinine should not be overlooked. Owing to greatly increased and cheaper supplies of the cinchona-bark, from which quinine is extracted, and to the employment of new and more economical processes, by which more quinine can be made in from three to five days than could be in twenty under the old system, the markets of the world in recent years have been overwhelmed with supplies of this article, and its price has declined in a most rapid and extraordinary manner, namely: from 16*s.* 6*d.* ($4.70) the ounce in the English market in 1877, to 12*s.* ($3) in 1880; 3*s.* 6*d.* (80 cents) in 1883; 2*s.* 6*d.*, in 1885; and to 1*s.* 6*d.* (30 cents), or less, in 1887. As quinine is a medicine, and as the increase in the consumption of medicines is dependent upon the real or fancied increase of ill-health among the masses, rather than on any reduced cost of supply (although, in the case of this specific article, decreased cost has undoubtedly somewhat increased its legitimate consumption), the problem of determining how a present and apparently future overproduction was to be remedied has been somewhat difficult of solution. But recently the large manufacturers in Europe have made an arrangement to put up quinine (pills) protected by gelatine, and introduce and offer it so cheaply in the East Indies and other tropical countries, as to induce its extensive consumption on the part of a vast population inhabiting malarious districts which has hitherto been deprived of the use of this valuable specific by reason of its costliness. And it is anticipated that by reason of its cheapness it may, to a considerable extent, supersede the use of opium among the poorer classes living along the Chinese rivers, who it is believed extensively consume this latter pernicious and costly drug, not so much for its mere narcotic or sensual properties, as for the relief it affords to the fever depression occasioned by malaria.

All this evidence, therefore, seems to lead to the conclusion that there is little foundation for the belief largely entertained by the masses, and which has been inculcated by many sincere and humane persons who have undertaken to counsel and direct them, that the amount of remunerative work to be done in the world is a fixed quantity; and that the fewer there are to do it the more each one will get. When the real truth is, that work as it were breeds work; that the amount to be done is not limited; that the more there is done the more there will be to do; and that the continued increasing material abundance which follows all new methods for effecting greater production and distribution, is the true and permanent foundation, and the certain assurance of continually increasing prosperity for the masses in the future.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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IV.—GEOLOGY (*concluded*).

LONG before the end of the struggle described in the last article, even at a very early period, the futility of the usual scholastic weapons had been seen by the more keen-sighted champions of orthodoxy; and, as the difficulties of the ordinary attack upon science became more and more evident, many of these champions began endeavors to patch up a truce. So began the third stage in the war—the period of attempts at compromise.

The position which the compromise party took was that the fossils were produced by the Deluge of Noah.

This position was strong, for it was apparently based upon Scripture. Moreover, it had high ecclesiastical sanction—some of the fathers had held that fossil remains, even on the highest mountains, represented animals destroyed at the Deluge—Tertullian was especially firm on this point, and St. Augustine thought that a fossil tooth discovered in North Africa must have belonged to one of the giants mentioned in Scripture.*

In the sixteenth century especially, weight began to be attached to this idea by those who felt the worthlessness of various scholastic explanations. Strong men in both the Catholic and the Protestant camps accepted it; but the man who did most to give it an impulse into modern theology was Martin Luther. With his keen eye he saw that scholastic phrase-making could not meet the difficulties raised by fossils, and he naturally urged the doctrine of their origin at the Deluge of Noah.†

With such support, it soon became the dominant theory in Christendom. Nothing seemed able to stand against it, but before the end of the same sixteenth century it met some serious obstacles. Bernard Palissy, one of the most keen-sighted of scientific thinkers in France, as well as one of the most devoted of Christians, showed that this theory was utterly untenable. Conscientious investigators in other parts of Europe, and especially in Italy, showed the same thing.‡ All in vain—in vain did good men protest against the injury sure to be brought upon religion by tying it to a scientific theory sure to be ex-

* For Tertullian, see his "De Pallio," c. ii (Migne, "Patr. Lat.," ii, 1033). For Augustine's view, see Cuvier, "Recherches sur les Ossements fossiles," fourth edition, vol. ii, p. 143.

† For Luther's opinion, see his "Commentary on Genesis."

‡ For a very full statement of the honorable record of Italy in this respect, and for the enlightened views of some Italian churchmen, see Stoppani, "Il Dogma e le Scienze Positive," Milan, 1886, pp. 203 *et seq.*

ploded ; the doctrine that fossils were the remains of animals drowned at the Flood continued to be upheld by the great majority of theological leaders for nearly three centuries as "sound doctrine," and as a blessed means of reconciling science with Scripture.* To sustain this scriptural view, efforts were put forth absolutely Herculean both by Catholics and Protestants.

In Germany, early in the seventeenth century (1612), Dr. Wolfgang Franz, Professor of Theology at Wittenberg, published his "Sacred History of Animals," described dragons with three ranges of teeth, and calmly added, "The greatest of these is the devil." This book was influential upon thought for a hundred years. It claimed to be designed for "students of theology and ministers of the word," and especially to instruct clergymen how, in biblical fashion, to utilize the various traits of animals to the edification of their hearers.†

In France the learned Benedictine, Calmet, in his great works on the Bible, accepted this view as late as the beginning of the eighteenth century, believing the mastodon's bones exhibited by Mazurier to be those of King Teutobocus, and held them valuable testimony to the existence of the giants mentioned in Scripture and of the early inhabitants of the earth overwhelmed by the Flood.‡

But the greatest champion appeared in England. We have already seen how, near the close of the seventeenth century, Thomas Burnet prepared the way in his "Sacred Theory of the Earth" by rejecting the discoveries of Newton, and showing how sin led to the breaking up of the "foundations of the great deep"; and we have also seen how Whiston, in his "New Theory of the Earth," while yielding a little and accepting the discoveries of Newton, brought in a comet to aid in producing the Deluge ; but far more important than these in his permanent influence was John Woodward, professor at Gresham College, a leader in scientific thought at the University of Cambridge, and, as a patient collector of fossils and an earnest investigator of their meaning, deserving of the highest respect. In 1695 he published his "Natural History of the Earth," and rendered one great service to science, for he yielded another point, and thus destroyed the foundations for the old theory of fossils. He showed that they were not "sports of Nature," or "models inserted by the Creator in the strata for some inscrutable purpose," but that they were really remains of living beings. So far, he rendered a great service both to science and religion ; but, this done, the text of the Old Testament narrative and the famous passage in St. Peter's Epistle were too strong for him,

* See Audiat, "Vie de Palissy," p. 412, and Cantu, "Hist. universelle," vol. xv, p. 492.

† See Franz, "Historia Animalium," edition of 1671, especially in the preface; also Perrier, "La Philosophie zoologique avant Darwin," Paris, 1884, p. 29.

‡ See Calmet, "Dissertation sur les Géants," cited in Berger de Xivrey, "Traditions tératologiques," p. 191.

and he, too, insisted that the fossils were produced by the Deluge. Strengthened by his great authority, the assault on the true scientific position was strong: Mazurier exhibited certain fossil remains of a mammoth discovered in France as bones of the giants mentioned in Scripture; Father Torrubia did the same thing in Spain; Increase Mather sent to England similar remains discovered in America, with a like statement.

For the edification of the faithful, such "bones of the giants mentioned in Scripture" were hung up in public places. Jurieu saw some of them thus suspended in one of the churches of Valence; and Henrion, apparently under the stimulus thus given, drew up tables showing the size of our antediluvian ancestors, in which the height of Adam was given as 123 feet 9 inches, that of Eve as 118 feet 9 inches and 9 lines.*

But the most brilliant service rendered to the theological theory came from another quarter; for, in 1726, Scheuchzer, having discovered a large fossil lizard, exhibited it to the world as the "human witness of the Deluge"; † this great discovery was hailed everywhere with joy, for it seemed to prove not only that human beings were drowned at the Deluge, but that "there were giants in those days." Cheered by the applause thus gained, he determined to make the theological position impregnable. Mixing together various texts of Scripture with notions derived from the philosophy of Descartes and the speculations of Whiston, he developed the theory that "the fountains of the great deep" were broken up by the direct physical action of the hand of God, which, literally applied to the axis of the earth, suddenly stopped the earth's rotation, broke up "the fountains of the great deep," spilled the water therein contained, and produced the Deluge. But his service to sacred science did not end here, for he prepared an edition of the Bible, in which magnificent engravings in great number illustrated his view and enforced it upon all readers. Of these engravings no less than thirty-four were devoted to the Deluge alone.‡

In the midst of this war appeared an episode very comical but very

* See Cuvier, "Recherches sur les Ossements fossiles," fourth edition, vol. vii, p. 56; also, Geoffroy St.-Hilaire, cited by Berger de Xivrey, "Traditions tératologiques," p. 190.

† "Homo diluvii testis."

‡ See Zöckler, vol. ii, p. 172. For the ancient belief regarding giants, see Leopardi, "Saggio." For accounts of the views of Mazurier and Scheuchzer, see Cuvier; also, Büchner, "Man in Past, Present, and Future," English translation, pp. 235, 236. For Increase Mather's views, see "Philosophical Transactions," vol. xxiv, p. 85. As to similar fossils sent from New York to the Royal Society as remains of giants, see Weld, "History of the Royal Society," vol. i, p. 421. For Father Torrubia and his "Gigantologia Española," see D'Archiac, "Introduction à l'Étude de la Paléontologie stratographique," Paris, 1864, p. 201. For admirable summaries, see Lyell, "Principles of Geology," London, 1867; D'Archiac, "Géologie et Paléontologie," Paris, 1866; Pictet, "Traité de Paléontologie," Paris, 1853; Vezian, "Prodrome de la Géologie," Paris, 1863; Haeckel, "History of Creation," English translation, New York, 1876, chapter iii; and,

instructive; for it shows that the attempt to shape the deductions of science to meet the exigencies of theology may mislead heterodoxy as absurdly as orthodoxy.

About the year 1760 news of the discovery of marine fossils in various elevated districts of Europe reached Voltaire. He, too, had a theologic system to support, though his system was opposed to that of the sacred books of the Hebrews. He feared that these new discoveries might be used to support the Mosaic accounts of the Deluge: all his wisdom and wit, therefore, were compacted into arguments to prove that the fossil fishes were remains of fishes intended for food, but spoiled and thrown away by travelers; that the fossil shells were accidentally dropped by Crusaders and Pilgrims returning from the Holy Land; and that sundry fossil bones found between Paris and Étampes were parts of a skeleton belonging to the cabinet of some ancient philosopher. Through chapter after chapter, Voltaire, obeying the supposed necessities of his theology, fought desperately the growing results of the geologic investigations of his time.*

But far more prejudicial to Christianity was the continued effort on the other side to show that the fossils were caused by the Deluge of Noah.

No supposition was too violent to support this theory, which was considered vital to the Bible. By taking the mere husks and rinds of biblical truth for truth itself, by taking sacred poetry as prose, and by giving a literal interpretation of it, the followers of Burnet, Whiston, and Woodward built up systems which bear to real geology much the same relation that the "Christian Topography" of Cosmas bears to real geography. In vain were exhibited the absolute geological, zoölogical, astronomical proofs that no universal deluge, or deluge covering any great extent of the earth, had taken place within the last six thousand or sixty thousand years; in vain did so enlightened a churchman as Bishop Clayton declare that the Deluge could not have taken place save in that district where Noah lived before the Flood; in vain did others, like Bishop Croft and Bishop Stillingfleet, and the nonconformist Matthew Poole, show that the Deluge might not have been and probably was not universal; in vain was it shown that, even if there had been a universal deluge, the fossils were not produced by it: the only answers were the citation of the text, "And all the high mountains which were under the whole heaven were covered," and, to clinch the matter, Worthington and men like him insisted that any argument to show that fossils were not remains of animals drowned at the Deluge of Noah was "infidelity." In England, France, and

for the most recent progress, Professor O. S. Marsh's "Address on the History and Methods of Paleontology," given at Saratoga in 1879.

* See Voltaire, "Dissertation sur les Changements arrivés dans notre Globe"; also, Voltaire, "Les Singularités de la Nature," chapter xii; also, Jevons, "Principles of Science," vol. ii, p. 328.

Germany, belief that the fossils were produced by the Deluge of Noah was insisted upon as part of that faith essential to salvation.*

But the steady work of science went on; not all the force of the Church—not even the splendid engravings in Scheuchzer's Bible—could stop it; and the foundations of this theological theory began to crumble away. The process was, indeed, slow; it required a hundred and twenty years for the searchers of God's truth, as revealed in Nature—such men as Hooke, Linnæus, Whitehurst, Daubenton, and Cuvier—to push their works under this fabric of error, and, by statements which could not be resisted, to undermine it. As we arrive at the beginning of the nineteenth century, science is becoming irresistible in this field. Blumenbach, Von Buch, and Schlotheim lead the way, but most important is the work of Cuvier. In the early years of the present century, his researches among fossils began to throw new light into the whole subject of geology: he was, indeed, very wary and diplomatic, and seemed, like Voltaire, to feel that "among the wolves one must howl a little." It was a time of reaction. Napoleon had made peace with the Church, and to disturb that peace was akin to treason. Still, by large but vague concessions, Cuvier kept the theologians satisfied, while he undermined their strongest fortress. The danger was instinctively felt by some of the champions of the Church, and typical among these was Chateaubriand; and in his best-known work, once so great, now so little—the "Genius of Christianity"—he grappled with the questions of creation by insisting upon a sort of general deception "in the beginning," under which everything was created by a sudden fiat, but with appearances of pre-existence. His words are as follows: "It was part of the perfection and harmony of the nature which was displayed before men's eyes that the deserted nests of last year's birds should be seen on the trees, and that the sea-shore should be covered with shells which had been the abode of fish, and yet the world was quite new, and nests and shells had never been inhabited." † But the real victory was with Brongniart, who, about 1820, gave forth his work on fossil plants, and thus built a barrier against which the enemies of science raged in vain.‡

Still the struggle was not ended, and, a few years later, a forlorn hope was led in England by Granville Penn.

His fundamental thesis was that "our globe has undergone only two revolutions, the Creation and the Deluge, and both by the immediate fiat of the Almighty"; he insisted that the Creation took place

* For a candid summary of the proofs from geology, astronomy, and zoölogy, that the Noachian Deluge was not universally or widely extended, see McClintock and Strong, "Cyclopædia of Biblical Theology and Ecclesiastical Literature," article "Deluge." For general history, see Lyell, D'Archiac, and Vezian. For special cases showing the bitterness of the conflict, see the Rev. Mr. Davis's "Life of Rev. Dr. Pye Smith," *passim*.

† "Génie du Christianisme," chapter v, pp. 1–14, cited by Reusch, vol. i, p. 250.

‡ For admirable sketches of Brongniart and other paleobotanists, see Ward, as above.

in exactly six days of ordinary time, each made up of "the evening and the morning"; and he ended with a piece of that peculiar presumption so familiar to the world, by calling on Cuvier and all other geologists to "ask for the old paths and walk therein until they shall simplify their system and reduce their numerous revolutions to the two events or epochs only—the six days of Creation and the Deluge."* The geologists showed no disposition to yield to this peremptory summons; on the contrary, the President of the British Geological Society, and even so eminent a churchman and geologist as Dean Buckland, soon acknowledged that facts obliged them to give up the theory that the fossils of the coal-measures were deposited at the Deluge of Noah, and to deny that the Deluge was universal. The combat deepened; churchmen and dissenters were alike aroused; from pulpit and press missiles were showered upon men of science. As typical we may take Fairholme, who in 1837 published his "Mosaic Deluge" and argued that no early convulsions of the earth, such as those supposed by geologists, could have taken place, because there could have been no deluge "before moral guilt could possibly have been incurred"—that is to say, before the creation of mankind. In touching terms he bewailed the defection of the President of the Geological Society and Dean Buckland—protesting against geologists who "persist in closing their eyes upon the solemn declarations of the Almighty." †

Still the geologists continued to seek truth, and those theologians who felt that denunciation of science as "godless" could accomplish little labored upon schemes for reconciling geology with Genesis. Some of these show amazing ingenuity, but an eminent religious authority, going over them with great thoroughness, has well characterized them as "daring and fanciful." ‡ Such attempts have been variously classified; but the fact regarding them all is that each mixes up more or less of science with more or less of Scripture, and produces a result more or less absurd. Though a few men here and there have continued these exercises, the capitulation of the party which set the literal account of the Deluge of Noah against the facts revealed by geology was at last clearly made.

One of the first evidences of the completeness of this surrender has been so well related by the eminent physiologist, Dr. W. B. Carpenter, that it may best be given in his own words: "You are familiar with a book of considerable value, Dr. W. Smith's 'Dictionary of the Bible.' I happened to know the influences under which that dictionary was framed. The idea of the publisher and of the editor was to give as much scholarship and such results of modern criticism as should be compatible with a very judicious conservatism. There was to be no objection to geology, but the universality of the Deluge was to be

* See the works of Granville Penn, vol. ii, p. 273.

† See Fairholme, "Mosaic Deluge," London, 1837, p. 358.

‡ See Shields, "The Final Philosophy," p. 340.

strictly maintained. The editor committed the article 'Deluge' to a man of very considerable ability, but, when the article came to him, he found that it was so excessively heretical that he could not venture to put it in. There was not time for a second article under that head, and, if you look in that dictionary, you will find under the word 'Deluge' a reference to 'Flood.' Before 'Flood' came, a second article had been commissioned from a source that was believed safely conservative. But, when the article came in, it was found to be worse than the first. A third article was then commissioned, and care was taken to secure its 'safety.' If you look for the word 'Flood' in the dictionary, you will find a reference to 'Noah.' Under that name you will find an article written by a distinguished professor of Cambridge, of which I remember that Bishop Colenso said to me at the time, 'In a very guarded way the writer concedes the whole thing.' You will see by this under what trammels scientific thought has labored in this department of inquiry." *

A similar surrender was seen when from a new edition of Bishop Horne's "Introduction to the Scriptures," the standard text-book of orthodoxy, its accustomed use of fossils to prove the universality of the Deluge was quietly dropped.†

The date of a similar capitulation in the United States was fixed, when somewhat later two divines, among the most eminent for piety and scholarship, inserted in the "Biblical Cyclopædia" published under their supervision, a candid summary of the proofs from geology, astronomy, and zoölogy that the Deluge of Noah was not universal, or even widely extended, and this without protest from any man of note in any branch of the American Church.‡

The time when the struggle was relinquished by enlightened theologians of the Roman Catholic Church may be fixed at about 1862, when Reusch, professor of theology at Bonn, in his work on "The Bible and Nature," cast off the old diluvial theory and all its supporters, accepting the conclusions of science.#

But, though the sacred theory with the Deluge of Noah as a universal solvent for geological difficulties was dead, there still remained in various quarters a touching fidelity to its memory. In Roman Catholic countries the old theory has been widely though quietly cherished and taught from the religious press, the pulpit, and the theological professor's chair: Pope Pius IX was doubtless in sympathy with this feeling when, about 1850, he forbade the scientific congress of Italy to meet at Bologna.‖

* See "Official Report of the National Conference of Unitarian and other Christian Churches, held at Saratoga, 1882," p. 97.

† This was about 1856; see Tylor, "Early History of Mankind," p 328.

‡ McClintock and Strong, "Cyclopædia of Biblical Knowledge," etc., article "Deluge."

See Reusch, "Bibel und Natur," chap. xxi.

‖ See Whiteside, "Italy in the Nineteenth Century," vol. iii, chap. xiv.

In 1856 Father Debreyne congratulated the theologians of France on their admirable attitude: "instinctively," he says, they still insist upon deriving the fossils from Noah's Flood.* In 1875 the Abbé Choyer published at Paris and Angers a text-book widely approved by church authorities, in which he took similar ground; and in 1877 the Jesuit father, Bosizio, published at Mayence a treatise on geology and the Deluge, endeavoring to hold the world to the old solution of the problem, allowing, indeed, that the "days" of creation were long periods, but making atonement for this concession by sneers at Darwin.†

In the Russo-Greek Church, in 1869, Archbishop Macarius, of Lithuania, urged the necessity of believing that Creation in six days of ordinary time and the Deluge of Noah are the only causes of all that geology seeks to explain; and, as late as 1876, another eminent theologian of the same church went even farther, and refused to allow the faithful to believe that any change had taken place since "the beginning" mentioned in Genesis, when the strata of the earth were laid, tilted, and twisted, and the fossils scattered among them by the hand of the Almighty during six ordinary days.‡

In the Lutheran branch of the Protestant Church we also find some echoes of the old belief. Keil, eminent in scriptural interpretation at the University of Dorpat, gave forth in 1860 a treatise insisting that geology is rendered futile and its explanations vain by two great facts—the Curse which drove Adam and Eve out of Eden, and the Flood that destroyed all living things save Noah, his family, and the animals in the ark. In 1867, Phillippi, and in 1869, Diedrich, both theologians of eminence, took virtually the same ground in Germany, the latter attempting to beat back the scientific hosts with a phrase apparently pithy, but really hollow—the declaration that "modern geology observes what is, but has no right to judge concerning the beginning of things." As late as 1876, Zugler took a similar view, and a multitude of lesser lights, through pulpit and press, brought these anti-scientific doctrines to bear upon the people at large—the only effect being to deaden the intellects of the peasantry in general and to arouse grave doubts regarding Christianity among the more thoughtful young men, who naturally distrusted a cause using such weapons.#

The results of this policy, both in Roman Catholic and in Protestant countries, are not far to seek. What the condition of thought is among the middle classes of France and Italy needs not to be stated here. In Germany, as a typical fact, it may be mentioned that there was in the year 1881 church accommodation in the city of Berlin for

* See Zöckler, vol. ii, p. 472.

† See Zöckler, vol. ii, p. 478, and Bosizio, "Geologie und die Sündfluth," Mayence, 1877, preface, p. xiv.

‡ See Zöckler, vol. ii, pp. 472, 571.

\# See citations in Zoeckler, Reusch, and Shields.

but two per cent of the population, and that even this accommodation was more than was needed. This fact is not due to the want of a deep religious spirit among the North Germans: no one who has lived among them can doubt the existence of such a spirit; but it is due mainly to the fact that, while the simple results of scientific investigation have filtered down among the people at large, the dominant party in the Lutheran Church has steadily refused to recognize this fact, and has persisted in imposing on Scripture the fetters of literal and dogmatic interpretation which Germany has largely outgrown.* A similar danger threatens every other country in which the clergy pursue a similar policy. No thinking man, whatever may be his religious views, can fail to regret this. A thoughtful, reverent, enlightened clergy is a great blessing to any country; and anything which undermines their legitimate work of leading men out of the worship of material things to the consideration of that which is higher, is a vast misfortune.

But, before concluding this part of the subject, it may be instructive to note a few special attempts at truces or compromises, such as always appear when the victory of any science becomes sure. Typical among the latest of these may be mentioned the attempt of Carl von Raumer in 1819. With much pretension to scientific knowledge, but with aspirations bounded by the limits of Prussian orthodoxy, he made a labored attempt to produce a statement which, by its vagueness, haziness, and "depth," should obscure the real questions at issue. This statement appeared in the shape of an argument, used by Bertrand and others in the previous century, to prove that fossil remains of plants in the coal-measures had never existed as living plants, but had been simply a "result of the development of imperfect plant embryos"; and the same misty theory was suggested to explain the existence of fossil animals without supposing the epochs and changes required by geological science.

In 1837 Wagner sought to uphold this explanation; but it was so clearly a mere hollow phrase, unable to bear the weight of the facts to be accounted for, that it was soon given up.

Similar attempts were made throughout Europe, the most noteworthy appearing in England. In 1853 was issued an anonymous work, having as its title "A Brief and Complete Refutation of the Anti-Scriptural Theory of Geologists": the author reviewed an old idea, but put a spark of life into it—this idea being that "all the organisms found in the depths of the earth were made on the first of the six creative days, as models for the plants and animals to be created on the third, fifth, and sixth days." †

* For these statements regarding Germany the writer relies on his personal observation as a student at the University of Berlin in 1856, as a traveler at various periods afterward, and as Minister of the United States in 1879, 1880, and 1881.

† See Zöckler, vol. ii, p. 475.

But, while these attempts to preserve the old theory as to fossil remains of lower animals were thus pressed, there appeared upon the geological field a new scientific column far more terrible to the old doctrines than any which had been seen previously.

For, just at the close of the first quarter of the nineteenth century, geologists began to examine the caves and beds of drift in various parts of the world; and, within a few years from that time, a series of discoveries began in France, in Belgium, in England, in Brazil, in Sicily, and in India which have established the fact that a period of time much greater than any which had before been thought of had elapsed since the first human occupation of the earth. The chronologies of Archbishop Usher, Petavius, Bossuet, and the other great authorities on which theology had securely leaned, fell. It was clearly seen that, no matter how well based upon the Old Testament genealogies and lives of the patriarchs, all these systems must go for nothing. The most conservative geologists were gradually obliged to admit that man had been upon the earth not merely six thousand, or sixty thousand, or one hundred and sixty thousand years. A very moderate estimate has made the time that the evolution of human civilization under the guidance of man has required fully a quarter of a million of years.*

The supporters of a theory based upon the letter of Scripture, who had so long taken the offensive, were now obliged to fight upon the defensive and at fearful odds. Various lines of defense were taken; but perhaps the most pathetic effort was that made in the year 1857, in England, by Gosse. As a naturalist he had rendered great services to zoölogical science, but he now concentrated his energies upon one last effort to save the literal interpretation of Genesis and the theological structure built upon it. In his work entitled "Omphalos" he developed the theory previously urged by Granville Penn, and asserted a new principle, called "prochronism." In accordance with this, all things were created by the Almighty hand literally within the six days, each made up of "the evening and the morning," and each great branch of creation was brought into existence in an instant. Accepting a declaration of Dr. Ure, that "neither reason nor revelation will justify us in extending the origin of the material system beyond six thousand years from our own days," Gosse held that all the evidences of convulsive changes and long epochs in strata, rocks, minerals, and fossils are simply "*appearances*"—only that and nothing more. Among these mere "appearances," all created instantaneously, were the glacial furrows and scratches on rocks, the marks of retreat seen in the wearing away of rocky masses, as at Niagara, the tilted and twisted strata, the piles of lava from extinct volcanoes, the fossils of every sort in every part of the earth, the foot-tracks of birds and reptiles, the half-

* See Professor Marsh's address as President of the Society for the Advancement of Science, in 1879.

digested remains of weaker animals found in the fossilized bodies of the stronger, the marks of hyenas' teeth on fossilized bones found in various caves, and even the skeleton of the Siberian mammoth at St. Petersburg with lumps of flesh bearing the marks of wolves' teeth—all these, with all gaps and imperfections, he urged mankind to believe came into being in an instant. The preface of the work is especially touching, and ends with the prayer that science and Scripture may be reconciled by his theory, and "that the God of truth will deign so to use it, and if he do, to him be all the glory." * And at the close of the whole book he declares: "The field is left clear and undisputed for the one witness on the opposite side, whose testimony is as follows: "In six days Jehovah made heaven and earth, the sea, and all that in them is." This quotation he placed in capital letters, as the final refutation of all that the science of geology had built.

In other parts of Europe desperate attempts have been made in recent times to save the letter of our sacred books by the revival of a theory in some respects more striking. To shape this theory to recent needs, vague reminiscences of a text in Job regarding fire beneath the earth, and vague conceptions of speculations made by Humboldt and Laplace, were mingled with Jewish tradition. Out of the mixture thus obtained Schubert developed the idea that the Satanic "principalities and powers" formerly inhabiting our universe plunged it into the chaos from which it was newly created by a process accurately described in Genesis. Rougemont made the earth one of the "morning stars" of Job, reduced to chaos by Lucifer and his followers, and thence developed in accordance with the nebular hypothesis. Kurtz evolved from this theory an opinion that the geological disturbances were caused by the opposition of the Devil to the rescue of our universe from chaos by the Almighty. Delitzsch put a similar idea into a more scholastic jargon; but most desperate of all were the statements of Dr. Anton Westermeyer, of Munich, in his "The Old Testament vindicated from Modern Infidel Objections." The following passage will serve to show his ideas: "By the fructifying brooding of the Divine spirit on the waters of the deep, creative forces began to stir; the devils who inhabited the primeval darkness and considered it their own abode saw that they were to be driven from their possessions, or at least that their place of habitation was to be contracted, and they therefore tried to frustrate God's plan of creation and exert all that remained to them of might and power to hinder or at least to mar the new creation." So came into being "the horrible and destructive monsters, these caricatures and distortions of creation," of which we have fossil remains. Dr. Westermeyer goes on to insist that "whole generations called into existence by God succumbed to the corruption of the Devil, and for that reason had to be destroyed"; and that

† See Gosse, "Omphalos," London, 1857, p. 5, and *passim*; and for a passage giving the key-note of the whole, with a most farcical note on coprolites, see pp. 353, 354.

"in the work of the six days God caused the devil to feel his power in all earnest, and made Satan's enterprise appear miserable and vain." *

Such is the last important assault upon the strongholds of geological science in Germany; and, in view of this and others of the same kind, it is little to be wondered at that, when, in 1870, Johann Silberschlag made an attempt to again base geology upon the Deluge of Noah, he found such difficulties that, in a touching passage, he expressed a desire to get back to the theory that fossils were "sports of Nature." †

But the most noted among efforts to keep geology well within the letter of Scripture is of still more recent date. In the year 1885 Mr. Gladstone found time, amid all his labors and cares as the greatest parliamentary leader in England, to take the field in the struggle for the letter of Genesis against geology.

On the face of it his effort seemed Quixotic, for he confessed at the outset that in science he was "utterly destitute of that kind of knowledge which carries authority," and his argument soon showed that this confession was entirely true.

But he had some other qualities of which much might be expected —great skill in marshaling words, great shrewdness in adapting the meanings of single words to conflicting necessities in discussion, wonderful power in erecting showy structures of argument upon the smallest basis of fact, and a facility almost preternatural in "explaining away" troublesome realities. So striking was his power in this last respect that a humorous London chronicler once stated that a bigamist had been advised, as his only hope, to induce Mr. Gladstone to "explain away" one of his wives.

At the basis of this theologico-geological structure, Mr. Gladstone placed what he found in the text of Genesis: "A grand four-fold division" of animated Nature "set forth in an orderly succession of times," and he arranged this order and succession of creation as follows: "First, the water population; secondly, the air population; thirdly, the land population of animals; fourthly, the land population consummated in man."

His next step was to slide in upon this basis the apparently harmless proposition that this division and sequence "is understood to have been so affirmed in our time by natural science that it may be taken as a demonstrated conclusion and established fact."

Finally, upon these foundations he proceeded to build an argument out of the coincidences thus secured between the record in the Hebrew sacred books and the truths revealed by science as regards this order and sequence, and he easily arrived at the desired conclusion with

* See Shields's "Final Philosophy," pp. 340 *et seq.*, and Reusch's "Nature and the Bible" (English translation, 1886), vol. i, pp. 318–320.

† * See Reusch, vol. i, p. 264.

which he crowned the whole structure, namely, as regards the writer of Genesis, that "his knowledge was divine." *

Such was the skeleton of the structure; it was abundantly decoated with the rhetoric in which Mr. Gladstone is so skillful an artificer, and it towered above "the average man" as a structure beautiful and invincible—like some Chinese fortress in the nineteenth century, faced with porcelain and defended with bows and arrows.

But its strength was soon seen to be unreal. A single shot from a leader in the army of science wrecked it. In an essay admirable in its temper, overwhelming in its facts, and absolutely convincing in its argument, Professor Huxley, late President of the Royal Society, and doubtless the most eminent living authority on the scientific questions concerned, took up the matter.

Mr. Gladstone's first proposition, that the sacred writings give us a great "fourfold division" created "in an orderly succession of times," Professor Huxley did not presume to gainsay.

But, as to Mr. Gladstone's second proposition, that "this great fourfold division . . . created in an orderly succession of times . . . has been so affirmed in our own time by natural science that it may be taken as a demonstrated conclusion and established fact," Professor Huxley showed that, as a matter of fact, no such "fourfold division" and "orderly succession" exist; that, so far from establishing Mr. Gladstone's assumption that the population of water, air, and land followed each other in the order given, "all the evidence we possess goes to prove that they did not"; that the distribution of fossils through the various strata proves that some land animals originated before sea animals; that there has been a mixing of sea, land, and air "population" utterly destructive to the "great fourfold division" and the creation "in an orderly succession of times"; that so far is the view presented in the sacred text, as stated by Mr. Gladstone, from having been "so affirmed in our own time by natural science, that it may be taken as a demonstrated conclusion and established fact" that Mr. Gladstone's assertion is "directly contradictory to facts known to every one who is acquainted with the elements of natural science"; that Mr. Gladstone's only geological authority, Cuvier, had died more than fifty years before, when geological science was in its infancy [and he might have added, when it was necessary to make every possible concession to the Church], and, finally, he challenged Mr. Gladstone to produce any contemporary authority in geological science who would support his so-called scriptural view. And, when in a rejoinder Mr. Gladstone attempted to support his view on the authority of Professor Dana, Professor Huxley had no difficulty in showing from Professor Dana's works that Mr. Gladstone's inference was utterly unfounded.

* See Mr. Gladstone's "Dawn of Creation and Worship," a reply to Dr. Réville, in the "Nineteenth Century," for November, 1885.

Both the scientific and theological world remained silent; there was nothing more to be said.

This being the case, Mr. Gladstone's wonderful fabric of coincidences between the "great fourfold division" in Genesis and the facts ascertained by geology fell of themselves. Professor Huxley's blow had shattered the central proposition—the key-stone of the supporting arch—and the last great fortress of the opponents of unfettered scientific investigation was in ruins.

But, in opposition to this attempt by a layman, we may put a noble utterance by a clergyman who has probably done more to save what is essential in Christianity among English-speaking people than any other ecclesiastic of his time. The late Dean of Westminster, Dr. Arthur Stanley, was widely known and beloved on both continents. In his memorial sermon after the funeral of Sir Charles Lyell he said: "It is now clear to diligent students of the Bible that the first and second chapters of Genesis contain two narratives of the creation side by side, differing from each other in almost every particular of time and place and order. It is well known that, when the science of geology first arose, it was involved in endless schemes of attempted reconciliation with the letter of Scripture. There was, there are perhaps still, two modes of reconciliation of Scripture and science, which have been each in their day attempted, *and each has totally and deservedly failed.* One is the endeavor to wrest the words of the Bible from their natural meaning and *force it to speak the language of science.*" And again, speaking of the earliest known example, which was the interpolation of the word "not" in Leviticus xi, 6, he continues: "This is the earliest instance of *the falsification of Scripture to meet the demands of science;* and it has been followed in later times by the various efforts which have been made to twist the earlier chapters of the book of Genesis into *apparent* agreement with the last results of geology—representing days not to be days, morning and evening not to be morning and evening, the Deluge not to be the Deluge, and the ark not to be the ark."

After a statement like this we may fitly ask: Which is the more likely to strengthen Christianity for its work in the twentieth century which we are now about to enter—a large, manly, honest, fearless utterance like this of Arthur Stanley, or hair-splitting efforts, bearing in their every line the germs of failure, like that made by Mr. Gladstone?

The world is finding that the scientific revelation of creation is ever more and more in accordance with worthy conceptions of that great Power working in and through the universe. More and more it is seen that inspiration has never ceased, and that its prophets and priests are not those who work to fit the letter of its older literature to the needs of dogmas and sects, but those who patiently, fearlessly, and reverently devote themselves to the search for truth as truth, in the faith that there is a Power in the universe strong enough to make truth-seeking safe and good enough to make truth-telling wise.

UNDERGROUND WATERS AS SOCIAL FACTORS.

By Professor G. A. DAUBRÉE,

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FROM the most remote times, the beneficent springs that jet from the interior of the earth have excited the gratitude and admiration of men. Like the sea and rivers, they have been deified by the peoples of the Indo-European family; and the worship that has been given to them, and the fables with which superstition has invested them, express the degree to which popular imagination has been struck by their mysterious origin, their inexhaustible flow, and their secret properties. The Greeks attributed to the fountain of Dodona, in Epirus, the faculty of discovering hidden truths and uttering oracles. The fountain of Egeria was supposed to possess the same power, and was intrusted to the guardianship of the Vestal Virgins. The fountains of Castalia, on the flank of Parnassus, and of Hippocrene, near Helicon, were believed to communicate the poetic spirit.

The Gauls had special veneration for the springs to which they went in search of health. The old romances of chivalry in their fancies of a fountain of youth, where spent forces and lost charms could be recovered, were only reproducing a myth of old Greece.

The perennial nature of springs, which was for a long time regarded as a sacred mystery, was also their most striking characteristic to those who sought to explain it without reference to religion and poetry. According to Aristotle's idea, which was adopted by Seneca and prevailed till the sixteenth century, "the interior of the earth contains deep cavities and much air, which must necessarily be cooled there. Motionless and stagnant, it is not long in being converted into water, by a metamorphosis like that which, in the atmosphere, produces rain-drops. That thick shadow, that eternal cold, that condensation which is disturbed by no movement, are the always subsisting and incessantly acting causes of the transmutation of air."

Simple and manifest as it appears to us now, the origin of springs was late in being recognized. Vitruvius suspected it, in his work on architecture; but it was Bernard Palissy who, after long studies on the constitution of the country in which he lived, overthrew the ancient fancies. According to his "Admirable Discourse on the Nature of Waters and Fountains, both Natural and Artificial," springs are generated by the infiltration of rain-waters or melted snow toward the interior of the earth, through cracks, till they reach "some place having a bottom of stone or contiguous rock." Palissy further sought means for establishing artificial fountains "in imitation of nature and as nearly approaching it as possible, by following the method of the sovereign Fountain-maker." He added the profound thought, which lies to-day at the foundation of experimental geology, "It is impossible to imitate Nature in anything, except we first contemplate her effects, and take her for our pattern and example." Hence we understand why springs are inexhaustible, because they are unceasingly renewed by the play of permanent forces; they result from a circulation which is in some respects symmetrical with the great aërial circulation of water.

Violent phenomena, like earthquakes, have certainly the prerogative of exciting the imagination. But other phenomena, though they take place slowly and in silence, are none the less worthy of interest; of this character are the mechanism and the fruitful action of the subterranean waters, of which springs are the exterior manifestation. Aside from their usefulness to man, the importance of the study of them is all the greater in that their work is not alone applicable to the present time. Since the crust of the earth has existed, and during all the periods of its development, the water circulating within it, sometimes at very high temperatures, has produced considerable and varied effects, which have in one way or another durably registered themselves, and the explanation of which is facilitated by recent experiments. It is, in fact, this incessant circulation which has engendered a large number of mineral species. The present functions of underground waters will first engage our attention, the examination of their part in the formation of minerals in ancient epochs being reserved for future studies.

As the course of rivers depends on the exterior contours of the soil, so is the *régime* of subterranean waters an immediate consequence of the nature and mode of arrangement of the masses through which they move.

Except for a very thin covering of vegetable soil, which is a kind of epidermis, the crust of the earth is composed of materials to which the name of rocks is applied, even when, like sand and clay, they are of little coherency. All of these masses have been formed successively, during periods of extremely long duration, and in the midst of conditions of which they bear in themselves the characteristic marks. They are veritable monuments, which delineate in their essential traits the successive revolutions of our globe.

The rocks constituting the greater part of the continents are called stratified, because they are divided into large parallel layers, to which are given the name of strata or beds. It is certain that the rocks of this category, whatever their composition, have been formed in the seas or lakes by sediments and organisms: a sure proof of this truth is furnished by their pebbles and sands, the origin of which can not be different from that of the present deposits of the ocean; the innumerable remains of fossilized marine animals are a still more eloquent testimony to it; and the disposition in beds completes the analogy with contemporaneous sediments. All of these formations may be traversed by mineral masses, disposed in more or less vertical irregular veins, which are usually contrasted in character to the incasing parts. Having risen from very deep regions, they are designated as eruptive rocks.

Some among these various materials are impervious to the passage of water. One of the most so among them is clay, a very abundant hydrated silicate of alumina, which, mixed with carbonate of lime, is also abundant as marl. Granite, and similar rocks, such as the schists, of which slate represents a well-known variety, have the same property, provided the fissures that traverse them are not too open. Thus, although the incessant invasion of water constitutes one of the chief obstacles to the miner's work, there are exploitations that keep quite dry in consequence of the impermeability of the incasing masses.

Other materials are easily permeable by water, as we may observe every day in sand and gravel. The same is the case with rocks which, not being themselves porous, are cut and cross-cut by crevices. Many compact limestones give instantaneous passage to water, which is drained away by their crevices as it would be by artificial conduits.

The *régime* of subterranean waters is exhibited in simple and clear characters in the deposits known as the ancient alluviums, the drift, and the quaternary deposits, which cover most of the continents as with a carpet. Their gravels and sands, usually associated with clays, greedily absorb water into interstices which represent a notable fraction (perhaps a third) of their total volume. Arrested in its descent by impermeable masses, it accumulates and forms a sheet or shallow body, from which it may be seen to exude through all the openings that may be made into it. This sheet has received several common names: as in France, *nappe des puits* (well-water) and *nappe d'infiltration* (infiltration-water); in Germany, *Grundwasser;* in England, ground-water; and in Italy, *acqua di suolo, acqua di livello.* A Greek term, which is cosmopolitan, is preferable, and it is found in the word *phreatic.* In a horizontal direction, the phreatic waters may occupy extensive surfaces, even whole countries, like the arenaceous deposits that serve as their receptacle.

An artificial excavation is not always necessary to make manifest the existence of ground-water. It appears in natural hollows of the soil, takes advantage of ravines of slight depth to issue in springs, which are sometimes impetuous and voluminous enough to constitute considerable streams at their source. The great sheet of the plain of Lombardy thus discharges itself into the beds of the rivers which plow the land in such a way that, after the streams have been drained by numerous irrigation-canals, they rise again spontaneously a little farther down, without apparently having received any new supply. The inexhaustible abundance of this interior sheet also receives here an agricultural application which is, perhaps, to the present time, unique. The water which is drawn from it by means of shallow wells called *fontanelle* is, in consequence of its nearly constant temperature, which is higher in winter than that of the ambient air, eminently suitable for irrigation. By forcing it to flow constantly in a thin sheet over the ground, the peasants are able, in a cold country, to cut their grass in January as in the summer-time. There are more than a thousand of these artificial subsoil springs, occupying a zone about two hundred kilometres long, extending from Ticino to Verona.

All rocks which are penetrable to water by means of fissures are also capable of containing phreatic water. The water in these sheets is not stagnant, but is animated by a slow and continuous motion. Among the facts that prove this we may cite the transportation in the subsoil of impurities like coal-tar, in the same direction, over several hundred metres, in a series of wells, the alignment of which marks the direction of the current. This movement is due to the general incline of the sheet.

In volcanic masses, the scoriaceous dejections and the lava-flows, with their cavities of various dimensions, offer no less facility for infiltrations. Rain-waters penetrate them and reappear lower down. Among the flows of fifty volcanoes in Auvergne, that which issues from the Puy de Gravenoire, near Clermont, gives rise to three springs: first at Fontanat; then at Royat, where they issue from a cave opened in the scoria surmounted by prismatic lava; and at the lower end of the flow the water is discharged under similar conditions to the advantage of the city of Clermont. In the same way, after having formed at Murois those scoriaceous caves to which George Sand has lent an infernal aspect, the long flow of the Tartaret gives out in its course a series of springs, around which several villages have grouped themselves. Thus fire is found to prepare the way for water by creating subterranean conduits for it.

The natural action of the waters which we have studied in the superficial deposits is indicated with equal clearness at a greater depth, in the midst of the stratified rocks. In these last, in fact, certain beds, very penetrable to water, alternate with others which arrest its passage. Whether the beds be horizontal or inclined, the relief of the soil is frequently so gashed that the impermeable support of the filtering and water-bearing stratum crops out and determines a flow by virtue of hydrostatic laws. These natural reservoirs thus produce springs which are permanent, provided successive rains furnish a sufficient supply of water, while they also sometimes simply give place to irregular oozings. These effusions occur not on the continents only, but also in sea-basins.

The sedimentary rocks, in their great thickness, inclose a succession of water-sheets or water-levels occupying distinct stages, and extending, with uniform characters, under whole countries, like the strata to which they are subordinated. It is proper to remark here that by the term water-sheet is not meant a real bed of water, lodged in a cavity, between solid masses that serve as walls to it, but water filling the minute interstices or the cracks of a rock. Continuous and regular in sand, these sheets are usually discontinuous and irregular in limestones and sandstones, in which the water only occupies more or less spacious fissures. When natural issues are wanting, human industry is able, by boring, to make openings down to the subterranean waters, which it causes to jet up to the surface, and sometimes to a considerable height above. The thought of undertaking such works is a very ancient one. The Egyptians had recourse to them forty centuries ago; and they were executed in France, in 1126, at Artois, whence the name of artesian wells has been given to them.

The water-levels of the cretaceous strata, from which the French artesian waters issue, are not always of advantage; but in the north of France and in Belgium they constitute the most formidable obstacle which miners have to encounter in reaching the coal-beds.

A striking confirmation of the theory of the source of supply of the artesian waters has been observed at Tours, where the water, spouting with great velocity from a well a hundred and ten metres in depth, brings up, together with fine sand, fresh-water shells and seeds, in such a state of preservation as to show that they could not have been more than three or four months on their voyage. Some of the wells of the wady Rir have also ejected fresh-water mollusks, fish, and crabs, still living, which must, therefore, have made a still more rapid transit. Caves, in limestone regions, play a part of the first order in the movements of the interior waters. Their presence is manifested at the surface by depressions of various shapes, such as are called "swallow-holes" in the north of England, and "sink-holes" in the United States. These cavities draw in the surface-waters and remove them from sight, to reappear at some other place, oftentimes in exceptionally voluminous fountains. They can be pointed out by the hundred in some parts of France, although only a small proportion of them are revealed by a visible discharge. The internal hollows are often aligned with dislocations of the ground, with which they are connected as effects of fractures, ultimately corroded and rounded off by water. The caves of Baume in the chain of the Jura correspond with a series of tunnel-holes and sinkings from the prolongation of which arises the river Seille. The Jurassic limestone of La Charente is marked by pits of various depths, with yawning mouths, into which the Tardouère and the Baudiat disappear near La Rochefoucauld, to gush out bubbling farther down and give rise to the Tourne. In the departments of the Var and the Maritime Alps, numerous sink-holes (*scialets*) feed, through secret channels, powerful springs that issue from the sea-bottom not far from the shore. The limestone around Mont Ventoux is riddled in a zone of seventy kilometres by natural wells and unfathomable pits, many of which bear names well known in the local legends. The waters which these rocks have stored up are poured out at their lowest point, and give rise, in a picturesque grotto, to the copious fountain of Vaucluse, which was formerly regarded as a beneficent divinity. Compared with the depth of the rains at different stations in the basin, the mean outflow of the fountain indicates a volume of infiltration equal to about six tenths of the quantity of rain-water. The limestone under the valley of the Loire, at Orleans, is plowed by interior currents from which the water-supply of the city is directly taken. The waters begin to be lost at a point some forty kilometres above the city, and return to the river about thirty kilometres below. The Iton, in the department of the Eure, fails to flow over the surface for several kilometres, and is called the Sec-Iton, or dry Iton ; but its waters are reached in their subterranean course by excavations of twenty metres. Similar facts may be observed in all parts of the globe. By a similar kind of drainage the cavernous limestone of the Apennines gives rise to the Aqua Martia, which was brought to Rome B. C. 608 by the consul Quintus Marcius, and which still continues to be of prime importance to the city ; "the most celebrated water in the universe," enthusiastically says Pliny, "a franchise of salubrity, one of the benefits granted to Rome by the favor of the gods."

A grain of truth sometimes lies at the bottom of the ancient fictions. Was not the observation of water-courses which are ingulfed and appear again the origin of the fable of the fountain of Arethusa, which the Greeks regarded as the reappearance of the river Alpheus? After a pursuit from Peloponnesus across the Ionian Sea, it was supposed to overtake the nymph personified in this fountain at the moment when it gushed out near Syracuse.

Besides moving through the interstices, fissures, and cavities of the crust of the globe, water exists everywhere in another state, in which, although quite invisible, it is of hardly less importance. All rocks, including the most compact ones, inclose water within their pores, however minute they may be, where it is held by capillary attraction, and is not apparent to our instruments of highest magnifying power. But it may be disengaged by desiccation, when the rock will be found to have lost a sensible fraction, some ten thousandths at least, of its weight. At the same time some of the qualities of the rock are modified ; for workers in slate, sandstone, and other rocks find it a matter of great difference, in the facility of their tasks, whether these stones still hold their quarry-water or have been dried in the air. The Romans availed themselves of the porosity of the onyx to soak it in certain liquids which would enliven the color of the stones that they used in their cameos. Under this form of intimate latent impregnation, though relatively in extremely feeble proportions, water is incorporated in the deep masses of the terrestrial crust, in immense absolute quantities, which are perhaps commensurable with the volume contained in the seas on the surface.

Various physical circumstances, such as the configuration of the soil and the vicinity of rivers or of the sea, have always had a great influence on the grouping and destinies of populations. The presence of particular minerals has had a similar determining influence. The useful metals, coal, and petroleum, have caused important cities to be created and to grow—as Virginia City, Leadville, Eureka, Oil City, and Petrolia, in the United States.

Underground water, a more commonplace substance, which has attracted much less attention, eminently deserves to be considered when we seek for the natural causes that have contributed to the formation of large agglomerations of men. Pliny the Elder remarked that mineral waters had peopled the earth with new cities and Olympus with new gods. Recent excavations in Gallic villages have brought to light vast *piscinæ*, marble monuments, theatres, statues, mosaics, and other unmistakable vestiges of a vanished luxury, as at Nereis, Vichy, Plombières, Bagnères-de-Luchon, and Aix in Provence. Universal celebrity attaches to Baiæ, where every Roman was ambitious to have a country-house, and the ancient splendor of which is attested by ruined temples and palaces. The word "bath" and its equivalents in different languages form the roots of many place-names. Those who lived by the manufacture of salt have necessarily grouped themselves around the marine springs from which their towns have received names embodying the root-form of the word salt or its equivalents—Salins, Chateau-Salins, Salival, Marsal, Salies, Salat, Salcons, Saltz, Saltzbronn, Salzhausen, Salzungen, Salzburg, Hall, Reichenhall, etc.

So populations tend to group themselves around copious fountains of fresh, potable water, where the frequency of the villages is often in striking contrast with the sparsity of the settlements in more arid localities. These contrasts result from the constitution of the soil. The junction of the Jurassic formation with the impermeable clays of the lias on which it rests is marked by a line of frequent springs, around which habitations and villages stand thickly, as in the vicinity of Metz; while the absence of masses of population on the neighboring limestones, where water is reached only at a great depth, is matter of special remark. This abundant and regular water-supply is found under these conditions, and at the same geological level, in many parts of France, England, and Germany, where it always attracts thick populations.

While the cretaceous table-lands of Champagne lack springs, they flow out in abundance at the foot of the cliffs. Many of them bear the generic name of "Somme," because they are the origin or the top of a brook—as Somme-Suippe, Somme-Vesle, Somme-Tourbe, Somme-

Bionne, and some fifty others. Around these springs, not far from arid and almost desert regions, are situated villages which gratefully borrow their names from the waters to which they owe their life; a kind of paternity which is not rare. In France numerous places, such as Fontainebleau, Fontanat, Fontanille, Fontvannes, Fontoy, Fontenoy, and Fontanay, derive their names from the Latin words *fons* and *fontanetum*, and some names are repeated many times. The same fact is apparent in Italy and Spain, where more than eight hundred names have the same origin; also in Germany, where the forms Brun, Bronn, and Born occur. The city of Paderborn is built upon forty springs which give rise to the Pader. Not far away is Lippspring, a word expressing the origin of the Lippe. This word "spring" in England and the United States, and "ain" in the north of Africa, convey the same idea. Eau, Aix, Aigues, Acqua, Aqua, and Waters, figure likewise in many words, with the signification of spring-water.

Nothing more clearly exemplifies the attractive force of subterranean waters than those collections of tilled-lands and habitations among the oases that are scattered over deserts. Strabo compared the Sahara to a panther's skin, the ground of which is the desert, while the black spots correspond with the somber verdure of the oases. These spots are aggregated in groups, like archipelagoes in the sea, in a zone of that desert which is confined between the thirtieth and thirty-seventh degrees of latitude. Algeria contains more than three hundred of them. Certain rainy regions, like Mount Atlas, send water by underground routes, which reaches them through sandy beds contained between impermeable strata of clay, and is thus protected against evaporation. Sometimes, when the water-sheet is not very deeply situated, it is utilized by digging holes where the roots of the palm-trees have grown down toward it. At many other points the water, impelled by the pressure upon it, opens a passage to the surface, and gives rise to springs or natural artesian wells. These appearances of water in the midst of arid and desert steppes constitute centers around which a life has developed itself under the protection from the sun and the simoom afforded by the palm and fruit trees. From a very remote epoch the natives have known how to imitate nature by opening issues for the interior water-sheet; but the perilous labor of digging was not inviting to workmen, and many of the ancient wells have become obstructed. The villages have become depopulated for want of water, the oases have shrunk, and gradually the desert has resumed the possession of the soil.

The first well bored after the French occupation of Algeria, at Tamema, spouted on the 19th of June, 1856, and was blessed by a marabout under the name of the Fountain of Peace. Numerous other borings revealed the existence of an underground river lying for a distance of a hundred and thirty kilometres beneath the wady Rir. At present one hundred and seventeen bored wells, together with five hundred native wells, give exit, from a mean depth of seventy metres, to a volume of water fully equal to that of the Seine, at Paris, in its lowest stage. Cultivated lands have been created, the native population has doubled, and the value of the oases has more than quintupled; a complete transformation of this part of the Sahara has been effected, by the agency of underground waters, within thirty years. Most of the manufacturing cities of the middle and north of England are situated upon the New Red Sandstone, where, besides excellent building-stone and proximity to the coal-fields, they enjoy the inestimable advantage of the presence of inexhaustible reservoirs of water purified by natural filtration, and easy of extraction. Belfast, in Ireland, is similarly situated. The water-bearing gravels are particularly worthy of attention from this point of view. With the inexhaustible and easily accessible provisions of water which they contain, they present to man an almost infinite expansion. This accounts for the existence upon these deposits, from most ancient times, of numerous important cities and capitals, like London, Paris, and Berlin. But in London the arenaceous and phreatic stratum has limitations which were opposed for several centuries to growth in particular directions. For a long time, according to Mr. Prestwich's observations, the population, by an instinct easy to understand, continued strictly concentrated on the principal water-sheet, and on a few isolated strips of gravel, as at Islington and Highbury. In the suburbs, likewise, the thick populations were collected on the larger gravel-beds rich in water, while in the same region, although the soil was everywhere cultivated and productive, the houses were very sparsely scattered. But the situation has greatly changed within the last seventy years, a supply of water having been brought from a distance, and the city has spread very rapidly over the clayey grounds.

Numerous populations still depend on wells for their drinking-water; Lombardy and Venice, with two million inhabitants; the extensive plains of Hungary; at least half of the German Empire; a part of the Russian Empire, seven times as large as France, and populated by about twelve million souls; and, according to the explorer Abbé David, the whole of the great northern plain of the Chinese Empire, containing more than a hundred million inhabitants. Besides these vast plains which represent more than a third of the continents, there are numberless valleys, with water-bearing subsoils, which have attracted to themselves aggregations of men. We can then affirm that a very important fraction of the human race depends for its principal drink wholly upon water which is furnished by the phreatic strata of ancient or modern alluviums. We never find such concentrations of inhabitants in countries where the soil is formed from granitic and schistose rocks, without being covered by disaggregated materials. These rocks permit water to descend to their interior only with the greatest difficulty. Springs are likewise weak among them, but very numerous; and the population is by force disseminated among them in isolated houses, and constitutes at most only little hamlets. The inhabitants, thus dispersed, differ in manners and character from those whom an indefinite abundance of underground water has drawn together and condensed into large groups.

Such are some of the social influences of subterranean waters, the importance of which has not always been fully appreciated.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

GLIMPSES AT DARWIN'S WORKING LIFE.

By WILLIAM H. LARRABEE.

THE qualities of Mr. Darwin most prominently brought out in the reading of his "Life and Letters" are his thorough humanism, his industry, his great modesty, amounting to even distrust of his powers, his perfect candor, and his kindly spirit. The piece of his autobiography which was published in the December number of the "Monthly" describes the beginning of his life, and shows how his boyhood was like that of the youth of the majority of men, with nothing in it to suggest a probability of future greatness; a commonplace, humdrum experience, in which all his most active instincts were repressed or ignored; and he was "trained"—that is, the effort was made, with his consent or against it, to fit him to the standard handed down from of old by the schools. As he wrote years afterward for Mr. Galton's "Life Histories," his schooling omitted all habits of observation or reasoning, and was of no peculiar merit whatever. He was considered, by those who had to do with him educationally, as "a very ordinary boy, rather below the common standard of intellect." It does not appear that he ever realized, until the world spoke it to him in tones that he could not fail to hear, that, in all his researches, he was doing more than the simplest, most insignificant work.

He fared but little better, so far as the recognized course was concerned, at the university (of Edinburgh), where the lectures, except those of Dr. Hope on chemistry, were "intolerably dull." But, during his second year there, his brother having ceased to attend the university, he was left to his own resources; and this proved to be to his advantage, for he became well acquainted with several young men fond of natural science. He accompanied a pair of his friends on their collecting tours for marine animals, and went trawling with the fishermen for other specimens. From some of these specimens, though without any regular practice in dissection, and having only a wretched microscope, he made a discovery, concerning which he read, in 1826, his first scientific paper before the Plinian Society. With these experiences as his start in real education, he told Mr. Galton that he considered that all that he had learned of any value had been self-taught. He found an unnamed professor's lectures on geology and zoölogy so intolerably dull that they produced on him as their sole effect the determination never, so long as he lived, to read a book on geology, or in any way to study the science. Happily, this determination gave way, under associations with more genial geologists and in the presence of geological phenomena.

From Edinburgh he went to Cambridge, where he was a ready listener to Professor Henslow's lectures on botany, associated with a "sporting set," became interested in pictures and music (for which he had no ear), and was fascinated with the passion for collecting beetles. "I am surprised," he says, "what an indelible impression many of the beetles which I caught at Cambridge have left on my mind. I can remember the exact appearance of certain posts, old trees, and banks where I made a good capture."

Darwin mentions his friendship with Professor Henslow as a circumstance which influenced his career more than any other. The professor kept open house once every week, which Darwin frequented regularly, and they became companions on long walks, so that he was known as "the man who walks with Henslow." Through Henslow Darwin formed the acquaintance of several other eminent men, the privilege of having associated with whom suggested to him, looking back from many years later in life, that there must have been something in him a little superior to the common run of youths, or else they would not have taken to him. "Certainly," he says, "I was not aware of any such superiority, and I remember one of my sporting friends, Turner, who saw me at work with my beetles, saying that I should one day be a Fellow of the Royal Society, and the notion seemed to me preposterous."

Professor Henslow's friendship secured a recommendation of Darwin to Captain Fitzroy, who was about to start on the famous expedition of the Beagle around the globe, "as amply qualified for collecting, observing, and noting anything worthy to be noted in natural history." The elder Darwin objected to his son's going, chiefly because he was intending to become a clergyman, and the voyage might end in withdrawing him from that profession; and Darwin came very near being rejected by Captain Fitzroy on account of the shape of his nose. The father's objections were overcome by means of the representations of Darwin's uncle, Josiah Wedgwood, and Fitzroy's by further acquaintance. The voyage, the story of which is familiar, was on the whole happy and instructive, and was marked by Darwin as by far the most important event in his life, and one which determined his whole career; and to it he always felt that he owed the first real training or education of his mind. But one sequence of it is to be deplored: he returned a permanent invalid. Of the scientific aspect of the voyage he speaks: "I also reflect with high satisfaction on some of my scientific work, such as solving the problem of coral islands, and making out the geological structure of certain islands, for instance, St. Helena. Nor must I pass over the discovery of the singular relations of the animals and plants inhabiting the several islands of the Galapagos Archipelago, and of all of them to the inhabitants of South America. As far as I can judge of myself, I worked to the utmost during the voyage from the mere pleasure of investigation, and from my strong desire to add a few facts to the great mass of facts in natural science. But I was also ambitious to take a fair place among scientific men—whether more ambitious or less so than most of my fellow-workers I can form no opinion."

Among the spoils brought home from the voyage were a number of specimens of fossil edentata, the discovery of which, says Mr. Francis Darwin, "has a special importance as a point in his own life, since it was the vivid impression produced by excavating them with his own hands that formed one of the chief starting-points of his speculation on the origin of species." Recording in July, 1837, the opening of the first note-book on transmutation of species, Darwin refers to the character of the fossils in the Galapagos Archipelago as the origin of all his views. In the early fall of 1837 he made his first observations on earth-worms, on which he based a paper in the Geological Society.

In September, 1838, while busy on his book on volcanoes and coral reefs, he wrote to Mr. Lyell concerning what was to be the grand achievement of his life: "I have lately been sadly tempted to be idle—that is, as far as pure geology is concerned—by the delightful number of new views which have been coming in thickly and steadily—on the classification and affinities and instincts of animals—bearing on the question of species. Note-book after note-book has been filled with facts which begin to group themselves *clearly* under sub-laws"; and to his cousin, W. D. Fox: "I am delighted to hear you are such a good man as not to have forgotten my questions about the crossing of animals. It is my prime hobby, and I really think some day I shall be able to do something in that most intricate subject, species and varieties." In another letter to Fox, he says: "The smallest contributions thankfully accepted; descriptions of offspring of all crosses between all domestic birds and animals, dogs, cats, etc., very valuable. Don't forget, if your half-breed African cat should die that I should be very much obliged for its carcass sent up in a little hamper for the skeleton; it, or any cross-bred pigeons, fowl, duck, etc., will be more acceptable than the finest haunch of venison or the finest turtle."

His eldest child was born in 1839, and he began upon him the observations which grew into the book on the "Expression of the Emotions." In October, 1846, Darwin informed Hooker that he was about to prepare some papers on the lower marine animals, after which he should begin looking over his ten-year-long accumulation of notes on species and varieties, by reason of which, when published, "I dare say I shall stand infinitely low in the opinion of all sound naturalists." The papers referred to were the treatise on cirripedes, to which eight years, instead of the "some months" he had anticipated, were devoted. The importance of this labor was not fully appreciated at the time—"I hate a barnacle," he said once in his weariness over the task, "as no man ever did before, not even a sailor in a slow-sailing ship"—but Sir Joseph Hooker has written to Mr. Francis Darwin: "Your father recognized three stages in his career as a biologist: the mere collector at Cambridge; the collector and observer in the Beagle, and for some years afterward; and the trained naturalist after, and only after, the cirripede work. That he was a thinker all along is true enough, and there is a vast deal in his writings previous to the cirripedes that a trained naturalist could but emulate. . . . He often alluded to it as a valued discipline, and added that even the 'hateful' work of digging out synonyms, and of describing, not only improved his methods but opened his eyes to the difficulties and merits of the works of the dullest of cataloguers. One result was that he would never allow a depreciatory remark to pass unchallenged on the poorest class of scientific workers, provided that their work was honest, and good of its kind. I have always regarded it as one of the finest traits of his character—this generous appreciation of the hod-men of science, and of their labors, . . . and it was monographing the barnacles that brought it about."

Darwin's letters, during the time he was engaged upon the "Origin of Species" and the related works, reveal the minute care with which he examined every trifle of a detail, and sought information from every possible quarter. Here we see him inquiring of Mr. Fox how early the tail-feathers of young fantail pigeons are developed, and remarking upon the difference in the weight of the foot or the wing of a wild and a tame duck. He wants to ascertain whether the young of our domestic breeds differ as much from one another as do their parents, and has no faith in anything short of actual measurement and the rule of three. He asks for lizards' and snakes' eggs to see whether they will float on sea-water, and whether they will keep alive thus floating for a month or two in his cellar.

In similar experiments on seeds he is so full of exultant anticipation that he will discover something that will conflict with Hooker's views, that the children are asking him often whether he shall beat Dr. Hooker; and when the seeds have germinated after a salt-water soaking that ought to have killed them, he has pangs of conscience and of vexation because the botanist seemed "to view the experiment like a good Christian." Then he acknowledges Hooker to be a good man to confess that he expected the cress—which vegetated after twenty-one days' immersion—would be killed in a week, "for this gives me a nice little triumph." But he is also making experiments at which Hooker would have a good right to sneer, "for they are so absurd, even in my opinion, that I dare not tell you." Everything—for he was trying to show that seeds and eggs could be carried on ocean-currents for indefinite distances and then develop—depended on the seeds floating. If, however, the seeds should sink, and sink after new trials, he would still not give up the floating, but, as a last resource, "must believe in the pod, or even whole plant or branch washed into the sea; with floods, and slips, and earthquakes, this must be continually happening, and, if kept wet, I fancy the pods, etc., would not open and shed their seeds." Again, he begins to think the floating question more serious than the germinating one, and is making all the inquiries he can on the subject. He tells how three plants have come up out of the earth perfectly inclosed in the roots of trees, and twenty-nine plants out of the tablespoonful of mud from the little pond; and how Hooker was struck when shown how much mud had been scraped off one duck's feet; these facts all being regarded as illustrating the ways in which seeds might have been transported to different islands. He thanks Wallace for an offer to look after horses' stripes; wants him to add donkeys, if there are any; and expresses a community of interest with him in bees' combs. He tries experiments on the struggle for existence with thick plantations of weeds in which the fate of each seedling is noted; and observes how young fir-trees flourish in ground that is fenced, while others, in the same plantation, unprotected from cattle, are invisible till closely looked for, and do not grow to be more than three inches high in twenty-six years.

While thus attentive to the minutest details of fact, he declares himself "a firm believer that without speculation there is no good and original observation"; and that "the naturalists who accumulate facts and make many partial generalizations are the *real* benefactors of science. Those who merely accumulate facts I can not very much respect."

The "Origin of Species" was at first intended to be published simply as an "Abstract," because the author regarded the use of some such term as the only possible apology for not giving references and facts in full, but the publisher objected to it, and the work appeared under the title it bears. There was a question whether it would be advisable to tell Mr. Murray that the book was "not more unorthodox than the subject makes inevitable"; or would it be better to say nothing to Mr. Murray, "and assume that he can not object to this much unorthodoxy, which, in fact, is not more than any geological treatise which runs slap counter to Genesis"?

Mr. Darwin had much difficulty with his style. While engaged upon his earlier works, he wrote: "I shall always feel respect for every one who has written a book, let it be what it may, for I had no idea of the trouble which trying to write common English could cost one," and, "It is an awful thing to say to one's self, 'Every fool and every clever man in England, if he chooses, may make as many ill-natured remarks as he likes on this unfortunate sentence.'" Eight years later, "Writing plain English grows with me more and more difficult, and never attainable." While writing the "Origin of Species," although, he says, "No nigger with lash over him could have worked harder at clearness than I have done," he found the style incredibly bad, and most difficult to make clear and smooth. When informed by Lubbock of a blunder he had made in the principle of some calculation, which it would require two or three weeks of work to correct, he exclaimed, "I am the most miserable, bemuddled, stupid dog in all England, and am ready to cry with vexation at my blindness and presumption"; and, "If I am as muzzy on all subjects as I am on proportion and chance, what a book I shall produce!"

The question of priority, which arose between Mr. Darwin and Mr. Wallace—both having an announcement of the theory of natural selection ready to publish at the same time—was settled in a manner creditable to both gentlemen, and which adds luster to the scientific spirit. The letters show how far from rivalry were the feelings of both. Another question of priority arose after the "Origin" was published, when Mr. Patrick Matthew brought forth an extract from a work on "Naval Timber and Architecture," published in 1831, in which, says Mr. Darwin, "he briefly but completely anticipates the theory of natural selection. I have ordered the book, as some few passages are rather obscure, but it is certainly, I think, a complete but not developed anticipation! . . . Anyhow, one may be excused in not having discovered the fact in a work on naval timber." Mr. Darwin published an apology to Mr. Matthew for his entire ignorance of this publication; but the latter could not get over the feeling that another man had won the fame that he had missed. It afterward appeared that a Dr. Schaaffhausen had nearly anticipated his view in a pamphlet published at Bonn in 1853; and still later that Dr. Wells had applied "most distinctly" the principle of natural selection to the races of men in his "Essay on Dew," which was read to the Royal Society in 1813. A letter to Herbert Spencer, written in 1858, acknowledging the receptions of a volume of essays from him, is of interest as showing the relations of the work of these two laborers in adjoining fields. "Your remarks," says Mr. Darwin, "on the general argument of the so-called development theory seem to me admirable. I am at present preparing an abstract of a larger work on the changes of species; but I treat the subject simply as a naturalist, and not from a general point of view, otherwise, in my opinion, your argument could not have been improved on, and might have been quoted by me with great advantage." Of one of the numbers of Spencer's "Principles of Biology" Mr. Darwin observed: "I feel rather mean when I read him; I could bear, and rather enjoy feeling that he was twice as ingenious and clever as myself, but when I feel that he is about a dozen times my superior, even in the master-art of wriggling, I feel aggrieved. If he had trained himself to observe more, even at the expense, by the law of balancement, of some loss of thinking power, he would have been a wonderful man." To E. Ray Lankester he acknowledged a suspicion that hereafter Spencer would be looked at as "by far the greatest living philosopher in England; perhaps equal to any that have lived."

A copy of the "Origin" was sent to Professor Agassiz, with the explanation that, "as the conclusions at which I have arrived on several points differ so widely from yours, I have thought (should you at any time read my volume) that you might think that I had sent it to you out of a spirit of defiance or bravado; but I assure you that I act under a wholly different frame of mind. I hope that you will at least give me credit, however erroneous you may think my conclusions, for having earnestly endeavored to arrive at the truth."

Mr. Darwin's relations with American men of science began with a letter to Asa Gray, in April, 1855, seeking for information on American Alpine plants, and offering an apology for the presumption of the writer, not a botanist, in making "even the most trifling suggestion to such a botanist as yourself." The correspondence was continued in frequent letters embodying discussions of subjects on which Mr. Darwin sought information or explanations from Professor Gray, the chief use of which was "to show a botanist what points a non-botanist is curious to learn; for I think every one who studies profoundly a subject often becomes unaware on what points the ignorant require information." After the publication of the "Origin," Mr. Darwin wrote to Professor Gray: "I should, for several reasons, be very glad of an American edition. I have made up my mind to be well abused; but I think it of importance that my notions should be read by intelligent men, accustomed to scientific argument, though not naturalists. It may seem absurd, but I think such men will drag after them those naturalists who have too firmly fixed in their heads that a species is an entity. . . . I should be infinitely obliged if you could aid an American edition." Professor Gray interested himself to secure a republication in the United States, and applied to a Boston house, while a New York house also moved in the matter. As he tells the story in a letter to Darwin: "All looked pretty well, when, lo! we found that a second New York publishing-house had announced a reprint also! I wrote then to both New York publishers, asking them to give way to the *author* and his reprint of a revised edition. I got an answer from the Harpers that they withdraw—from the Appletons that they had got the book *out* (and the next day I saw a copy); but that, 'if the work should have any considerable sale, we certainly shall be disposed to pay the author reasonably and liberally.' The Appletons being thus out with their reprint, the Boston house declined to go on. So I wrote to the Appletons, taking them at their word, offering to aid their reprint, to give them the use of the alterations in the London reprint, as soon as I find out what they are, etc., etc." This was on the 23d of January, 1860. On the 22d of May of the same year, Mr. Darwin wrote acknowledging "a very pleasant remittance of £22" ($110), and adding, "If you have any further communication to the Appletons, pray express my acknowledgments for their generosity; for it is generosity, in my opinion." While Darwin and Gray were corresponding concerning the interests of the book and the reviews of it—favorable and adverse—in American periodicals, our civil war broke out; and we have, on the 5th of June, 1861, the expression:

"I never knew the newspapers so profoundly interesting. North America does not do England justice; I have not seen or heard of a soul who is not with the North. Some few, and I am one of them, even wish to God, though at the loss of millions of lives, that the North would proclaim a crusade against slavery. In the long run, a million horrid deaths would be amply repaid in the cause of humanity. What wonderful times we live in! Massachusetts seems to show noble enthusiasm. Great God! how I should like to see the greatest curse on earth—slavery—abolished!" In September Darwin said, "If abolition does follow with your victory, the whole world will look brighter in my eyes, and in many eyes."

Professor John Fiske, whose "Cosmic Philosophy," and Professor Morse, whose address on "What American Scientists have done for Evolution," he read with interest; and Professor Marsh, whose "Odontornithes" he regarded as having "afforded the best support to the theory of evolution which has appeared within the last twenty years," were other American scientific correspondents.

Mr. Darwin was not inclined to make public statements respecting his religious views, because he felt that a man's religion is an essentially private matter concerning himself alone, and because he thought that a man ought not to publish on a subject to which he had not given special and continuous thought.

In his twentieth year he had determined to become a clergyman, with full acceptance in his mind of the doctrines of the Church of England. While on the Beagle his faith in the literal interpretation of the Scriptures was regarded as something remarkable; but it was gradually surrendered in the face of his critical reflections, though very unwillingly, and disbelief creeping over his mind at a rate so slow as to give no distress, became at last complete. At a later period he was doubtful respecting the existence of a personal God; but, as he wrote in 1879, he was never an atheist in the sense of denying such existence, but considered that the term agnostic would be the more correct designation of his state of mind. He acknowledged to Miss Julia Wedgwood that the result of his reflections respecting design in Nature had been a maze, and that "where one would most expect design—viz., in the structure of a sentient being—the more I think on the subject, the less I see proof of design." He wrote to Mrs. Boole in 1866, "It has always appeared to me more satisfactory to look at the immense amount of pain and suffering in this world as the inevitable result of the natural sequence of events—i. e., general laws—rather than from the direct intervention of God, though I am aware this is not logical with reference to an omniscient Deity."

He wrote to a Dutch student in 1873: "The impossibility of conceiving that this grand and wondrous universe, with our conscious selves, arose from chance, seems to me the chief argument for the existence of a God; but whether this is an argument of real value I have never been able to decide. . . . The safest conclusion seems to me that the whole subject is beyond the scope of man's intellect; but man can do his duty." In 1879 he wrote in the letter first made public by Haeckel: "Science has nothing to do with Christ, except in so far as the habit of scientific research makes a man cautious in admitting evidence. For myself, I do not believe that there ever has been any revelation. As for a future life, every man must judge for himself between conflicting vague probabilities." When the Duke of Argyll remarked to him in 1885, concerning some wonderful adaptations which he had described, that it was impossible to look at them without seeing that they are the effect and the expression of mind, he replied, "Well, that often comes over me with overwhelming force, but at other times it seems to go away."

One of the characteristics of Mr. Darwin's manner of working was his great respect for time. He used to say that saving the minutes was the way to get work done, and never allowed a few spare minutes to go to waste from thinking that it was not worth while to set to work. He would work up to the very limits of his strength and then suddenly stop, saying, "I believe I mustn't do any more." All his movements were performed as quickly as possible; but, in cases requiring care, he gave it. He saved a good deal of time through not having to do things twice—that is, by doing them right at first. His love of experiment was very strong, and was exemplified by his often saying, "I sha'n't be easy till I have tried it"; and he stuck unflinchingly to a subject on which he had once begun, for he could not bear to be beaten, and was accustomed to recall the phrase, "It's dogged as does it."

He was fond of light reading, and particularly enjoyed having novels read to him—provided they had good endings. He also liked a biography or a book of travels occasionally, but cared little for the old standards. In later life, he felt his taste for recreation fading out, and he regretfully wrote to Sir Joseph Hooker, in 1868, respecting the "Messiah": "It is the one thing that I should like to hear again, but I dare say I should find my soul too dried up to appreciate it as in old days; and then I should feel very flat, for it is a horrid bore to feel, as I constantly do, that I am a withered leaf for every subject except science. It sometimes makes me hate science, though God knows I ought to be thankful for such a perennial interest, which makes me forget for some hours every day my accursed stomach." An extreme tenderness for suffering marked his whole life. But when the subject of vivisection came under discussion, he recognized the importance of experimental physiology. While insisting upon the imposition of close restrictions in operation, and the adoption of all possible measures to save pain to the objects of experiment, he approved of that method of study, for the sake of the wide and permanent relief from suffering that would accrue from the knowledge thereby gained.

THE INDIANS OF BRITISH COLUMBIA.

By Dr. FRANZ BOAS.

A PICTURE of the Indians whose life we intend to describe in the following pages does not bear the well-known features of the renowned hunters and daring warriors whom we are acquainted with from "Leather-Stocking" and other Indian stories. They are no noble figures roaming on horseback over the endless prairie; they are a quiet people of fishermen, whose appearance is so different from that of our Indians that at first sight one feels astonished and disappointed. They are of short stature, light complexion, with prominent cheeks, straight black hair, and sparkling black eyes. Their type reminds one so much of that of the races of Eastern Asia that in British Columbia they are generally considered the descendants of shipwrecked Japanese navigators.

The stranger who first visits Victoria, the capital of British Columbia, is struck by the great number of Indians who live in the city. They wear clothing of European style. The men work on the wharves and steamers, sell fish and skins, or are occupied in different trades, particularly as carpenters. The women wash and work for the whites, or stroll idly about the streets. The suburbs of Victoria are almost exclusively inhabited by the Indians. There they live in miserable, filthy shanties and sheds, or even in thin canvas tents. The city has about thirteen thousand inhabitants, and of these about two thousand are Indians who stay there over summer. Besides these, about three thousand Chinese, many Sandwich-Islanders, a few negroes, and a white population coming from all parts of Europe and America, live in the city. The internationality of the population and its easy-going ways give it a peculiar character.

But this is not the place to study the customs of the Indian. We must visit him in his village, where he lives undisturbed by the contact with Europeans, according to his ancient customs.

When the rainy season of fall approaches, most of the Indians who worked in Victoria over summer return to their villages, either in their own canoes or on board of a small steamer plying between the city and the settlements all along the coast as far as the boundary of Alaska. When in the fall of 1886 I visited the Indian villages of that district to study the languages and customs of the natives, I joined a young Indian, who after a few years' absence was returning with his wife and children to his country. Soon the houses of Victoria disappeared from our view, and at the small miners' town of Nanaimo we had reached the terminus of European civilization. Dense woods, uninterrupted by fields or houses, cover the mountains and descend to the shore. No lighthouse warns the ship of the dangerous rocks and shoals which obstruct the narrow straits, and it seems almost incredible that it is only a few hours since we have left the busy town. The European population of the coast consists of a few traders, salmon-fishers, and missionaries, who lead a lonesome life among the Indians. Four days we had sailed through the narrow waters and approached the home of my Indian friend. He was unable to restrain his impatience any longer. By singing and dancing he expressed his joy at the return to his countrymen. At last the village appeared, which had been hidden from sight by a long island. It consisted of a row of well-built wooden houses, painted with gay figures, standing on a small opening. Canoes dug out of a single tree lay on the beach. As soon as the villagers heard the steam-whistle, they manned some boats and set out to meet the vessel. The luggage was thrown into the boats, and we sat down on top of it; the Indians paddled toward the land, while the steamer slowly disappeared from view. My friend had informed one of the chiefs of the village that I wished to stay with him. He came up to me in all his dignity and invited me to follow him into his house. Here I was at my leisure to look about among the people among whom I was so suddenly thrown.

The only garment of the natives consists of a cotton shirt, and a woolen blanket thrown over the shoulders like a toga; the women wear petticoats besides. Their hair is arranged in two braids, while the men tie a gay kerchief or a piece of skin round their heads to keep back the hair. Wondering, they surrounded the stranger, curious to know what might have induced him to visit their lonely village.

The house forms a square, the side of which is about fifty feet long. It is built of heavy planks which are tied to beams. The roof is also built of planks, and rests on a long timber which forms the ridge of the house. This timber rests on two pairs of uprights, one standing in the front and forming the door, the other one standing in the rear of the house. They are beautifully carved, and represent the crest of the house-owner. Around the walls an elevated platform, about four feet wide, is built, on which there are small sheds serving for bedrooms.

Each corner of the house is occupied by one family, their partition being divided from the rest by screens made of mats. An enormous carved chair, large enough for a whole family, stands in each of these compartments facing a blazing wood-fire. The smoke fills the whole house, and escapes only slowly through a small opening in the roof and through the chinks of the planks.

The arrival of the stranger was an interesting topic of conversation, and groups of men and women were seen in eager discussion in our house and on the street which runs in front of the houses. My friend tried to explain to them that I did not intend to interfere with their feasts and usages, and that I did not want anything but to stay some time in their village and to trade with them. His endeavors, however, were unsuccessful, and the chief deemed it necessary to arrange a general council in which the presence of the stranger was to be discussed. In the evening I was told that on the next day a great feast was to be held and that my presence was requested. Of course I felt highly honored and was glad to have so soon an occasion to observe the peculiar feasts and customs of the natives.

Early in the morning all families were astir. The young men went out in their canoes at daybreak and returned about nine o'clock with heavy logs in tow, which were drawn upon the beach, split, and carried into the house in which the feast was to be held. Here men and women were busily engaged in preparations. The compartments were torn down, the frames and screens being taken away. The house was swept, and wood for a large fire piled up in the center of the building. Dried halibut, which is kept in large boxes, and fish-oil, which is preserved in tubes made of dried kelp, were taken from the store-rooms and served in enormous carved wooden dishes which represent the crest animal of the host's family. When everything was prepared, the men assembled. Women are not permitted to partake in the feasts except the eldest daughters of chiefs—if the eldest child happens to be a girl. Their faces are painted red and black; they are wrapped up in their best blankets; their hair is carefully arranged and frequently covered with eagle-down. A few old men carry carved sticks, and all sit on mats which are spread at the foot of the platform which encircles the floor of the house. The host and a young man who was hired for the purpose looked after the fire. When all were assembled, one man took up the drum, a large box made of bent wood, which is painted with the host's crest, and began beating the time with his fist. The old men joined him with their dancing-sticks, the rest of the men clapping their hands. Then the singing-master, who instructs daily the old and young men, started the tune, and the chorus joined him after a few bars. When the text of the song is long, he calls out the text of every verse, while the time-beating goes on and the chorus repeats the words, singing. The first song was a war-song:

"Do not fight with daggers; kill your enemies with your arrows. Thus the chief said, and his heart was glad when he had killed his enemy. He was as strong as two thunder-birds when he went into the battle."

An ancient law demands that four songs be sung before the meal can be served and the debate can be opened. The young man dished out the meal, and while all were eating one of the chiefs rose, wrapped his blanket around him so as to leave one arm free, and began his speech. Of course, I did not understand him, but I saw from his expressive gestures that he spoke of me. After his long speech was finished, an interpreter was sent to me and translated the contents of the speech into Chinook.

I have to remark here that the Canadian Government tries to suppress the feasts of the natives, and that the Indian agent had occasionally threatened this tribe to send a man-of-war if they would not stop their feasts. As I was unknown to any of them, and even my friend had made my acquaintance only very recently, I was suspected to have come there in order to report to the Government, and to send a man-of-war. Therefore the chief spoke thus :

" We want to know whether you have come to stop our dances and feasts, as the missionaries and agents who live among our neighbors try to do. We do not want to have anybody here who will interfere with our customs. The agent has told us that he would send a man-of-war if we should continue to do as our grandfathers and great-grandfathers have done. But we do not mind his words. Is this the white man's land ? The agent says this is the Queen's land ; but no! it is mine. Where was the Queen when God sent down Qanikila ?* Where was the Queen when Qanikila gave this land to my great-grandfather and told him, 'This will be thine'? My father owned this land and was a mighty chief ; now it is mine. And when your man-of-war comes, let him destroy our houses. Do you see those woods? Do you see those trees? We shall cut them down and build new houses, and live as our fathers did. We will dance when our laws command us to dance, we will feast when our hearts desire to feast. Do we ask the white man, 'Do as the Indian does'? No, we do not. Why, then, will you ask us, 'Do as the white man does'? It is a strict law that bids us to dance. It is a strict law that bids us to distribute our property among our friends and neighbors. It is a good law. Let the white man observe his law ; we shall observe ours. And now, if you are come to forbid us to dance, begone ; if not, you will be welcome to us."

I was expected to answer this speech, and did so through the interpreter. I assured them of my friendly intentions, and said that I would not send a man-of-war—well I might promise that !—that I had no intention to interfere with their ways and customs ; and, in order to show that I was their friend, I invited the whole tribe to a feast on the next night.

* Qanikila is the son of the deity in the traditions of this people.

The effect of this speech was very great. It seemed that all of a sudden the former distrust had vanished. Every one was eager to assure me that the Indians' hearts were glad when they heard my words, and that they hoped to see me long in their village. Soon after this the feast was at an end; the men carried the rest of their meals home to their wives and children, who returned the empty dishes the same night; and now every house was still and quiet, the inhabitants having gone to sleep.

The next morning they took up their regular occupations. Firewood was carried into the houses and the fires were lighted. Men and women got water from the near brook, and were busy washing their blankets and petticoats; the old men sat lazily on the wood platforms which are erected on the sea-side of the street, and looked at the fishermen who were out at sea in their canoes, talked over the events of the day, or passed the time in gambling. The platform is the favorite place of the Indian. There he sits for hours and hours, wrapped up in his blanket, and leaning on the heavy board which forms its balustrade. Clumsy steps cut out of large trees lead from the street and the platforms down to the beach, where fish are drying, where heavy logs of drift-wood are piled up for fire-wood, and where large cedars, which have been cut down with great difficulty and towed to the village, are burned out and dug out to become in the hands of the skillful native a swift and strong boat. Children are playing on the beach. They paddle about in small canoes and practice all kinds of sport.

About noon the hunters had returned, and the natives prepared for the feast which was to take place in the evening. They were determined to celebrate it by a great dance. In the flattering way which is characteristic of these tribes, one of the chiefs said to me: "When a great chief comes here, we do not always honor him by a dance, but as you are good and a mighty chief, and as you come from a far-away country, we wish to make your heart glad. Go into your house and await us!" The house in which I lived was prepared in the same way as described before, and I hired a young man to cook the meal for the sixty men whom I was expecting. When the meal was ready, the dancers had finished their preparations. The wife of my host took her place near the fire, and kept fish-oil ready for pouring it into the fire, which then blazes up and lightens the whole house. Now the dancers had assembled at the opposite end of the village. With sticks and fists they beat the time on the walls of the houses, and slowly approached, singing the dancing-song. Now the door of the house was torn open and the dancers appeared, one of the chiefs—a man of over sixty years—first. He was clothed in an old uniform and carried the British flag. The next day I learned that he had received both from the Superintendent of the Indians of British Columbia, with an appointment as sheriff, and the particular instruction to watch that no dances were held! How well he performed this duty was seen on the evening when he came into our house, the chief dancer, flourishing the flag and dancing in grotesque movements. The walls of the house shook under the heavy fists and sticks of the dancers who beat the time outside and now entered one by one. The two dancers next to enter had each a blanket tied round his loins, the upper part of the body being naked. A carved wooden snake with two heads—the fabulous Sisiutl—was tied to the waist, and about their necks they wore rings of hemlock-branches. In the right hand they carried two sticks ornamented with gay ribbons; in the left they flourished bows and arrows. Their faces were painted black, and their hair was kept back by a tie of seal-skins with a bunch of red feathers attached to it. These were followed by two men wrapped up in white blankets and wearing stuffed mink-skins as head-dresses. The next dancer carried a rattle in his hands, which he hid under his dancing-apron. Then the rest of the dancers rushed into the room and formed a wide circle around the two men carrying the snake-carvings. Now began a wild song in which the chorus occasionally joined. As soon as the chorus fell in, the minks and the man carrying the rattle rushed into the center of the circle and jumped about in the wildest fashion. The women and children who stood by became greatly excited, and it looked very droll to see the little ones, who could hardly stand on their legs, dancing and imitating the motions of the performers. After the first round was finished, a new cry was heard outside, the door opened, and in came twelve boys, all naked, their little bodies whitened with lime, and all kinds of figures painted on them in red and black. Their hair was rubbed with a mixture of oil and lime, and looked like the bristles of a brush. The leader of the boys was an elderly man, who remained standing in the entrance of the house with uplifted hands, and directing the boys by rhythmical motions of his arms and his body. The figures of these dances were really artistic and symmetrical. At the end of the performance all left the house in grand procession and made a terrible noise before the entrance of every house of the village. If the owner's wife made the fire blaze up by pouring oil into it, this was an invitation for them to come in and perform a short dance. Where all remained dim and dark they passed by.

This dance had been invented when the daughter of the chief of a neighboring tribe married the young chief of this village. When the approach of the bride was announced, the men connected three boats by heavy planks, thus forming an extensive platform. They went on this raft to meet the strangers and welcomed them dancing this dance on the water. The boats of the young woman were loaded with her dower: boxes filled with blankets, valuable copper plates, and the *gyiserstal*—the latter being a heavy board, cut so as to represent a human jaw-bone. The front is set with sea-otter teeth. This object is given to the bridegroom, who thus obtains the right to command his wife to talk or to be silent.

The marriage ceremonies of these tribes are very complicated. The young man must buy his bride from his future father-in-law before he gets his consent to marry her. But even then the formalities he has to go through are not at an end. He must come into the house where the girl lives and sit down next to the door. Then the girl's parents know what he comes for. They scold him and abuse him as much as they can for two days. On the third day the mother gives him a mat to sit on, and on the fourth he gets a little food. Then he is invited to the fire, and the parents give their consent to the marriage. The chief of the gens to which the young man belongs now comes in great state and brings the price, which was agreed upon beforehand, to the parents, who in their turn on the next day pay a certain price, through the chief of their gens, to the parents of the young man. Then both parties give a great feast. At last the friends of the young man go to fetch the bride. They cover the road leading from their house to the beach with gay mats and embark in their boats. After a few hours they land before the house of the girl, though it may stand close to theirs, and lay mats from the beach to the house-door. Then the chief of the girl's gens dresses himself up with all his dancing-ornaments, takes her by the hand, and leads her to the boat, where she is received by the chief of the bridegroom's gens. Then they return to their house, and the marriage ceremonies are at an end.

The efforts of the missionaries to Christianize these Indians have in most places been very unsuccessful. The history of the mission is quite interesting, and has been the subject of some publications in our journals and newspapers. But, as in all these only one side of the Indian question in British Columbia has been presented, a few remarks on the state of affairs, which is not without influence upon our Alaska Indians, may not be out of place.

The first to take up the work energetically was Mr. Duncan, who established himself at Fort Simpson among the Tsimpshian tribe. His influence upon the Indians has been enormous.

These results have been brought about by the peculiar method Mr. Duncan applied in Christianizing these Indians. He did not deem it unworthy to trade for his pupils, and to teach them to *work*, instead of instructing them in the Christian faith alone. Thus he improved their condition, and was remarkably successful. In order to protect his adherents from the influence of the heathenish Indians and of the worse influences of the white traders, he emigrated with them from Fort Simpson and founded the settlement of Mestlakahtla, or more properly Meghtlaqatla (*gh* being pronounced like the German *ch*, and *q* being a very guttural *k*). He succeeded in keeping the destructive whisky-trade from his followers.

His success encouraged the missionaries of other churches. The Catholic Church had tried to convert and civilize the tribes on both coasts of Vancouver Island and the mainland opposite. After a long series of years, they abandoned the task among the so-called Kwakiutl tribes in despair. Their success among the tribes on the mainland opposite Victoria was far greater, and on the west coast of Vancouver Island they are making rapid progress at the present time.

When the Catholic Church left the Kwakiutl tribes, the Church of England took up the work, but with little or no success; while near Victoria they and the Methodists were successful. From experience derived from a life with the Indians of all these tribes, it may safely be said that the only successful way of civilizing these tribes—and this refers to the Alaska tribes as well as to those of British Columbia—is to teach them to work. Then they will gradually abandon their fearful cannibal ceremonies and Shamanistic dances.

The traditions of these natives make them very ready to accept the Christian faith, as their principal legend tells of the Son of God, who descended from heaven and traveled all over the world, doing miracles everywhere. But I must state here that even the sincerest Christians among the Indians, who observe Sunday and preach in their churches, are not thoroughly civilized; that is, their way of thinking is not ours, but still under the influence of their ancient customs. The best proof of this is the fact that any one returning to a heathenish tribe will again adopt their mode of life, a very few perhaps excepted. This is not meant as a reproach to the missionaries or Indians. It is founded in psychologic laws, and we only consider it a mistake to believe that an acculturation to our civilized ways is a thorough civilization. This is true in regard to Duncan's Indians and all others.

Though remarkable progress has been made and the condition of many tribes has greatly improved, a general dissatisfaction exists among the Indians of British Columbia, which led to disturbances among those of Metlakahtla. There are two reasons for this state of affairs, which is of some importance, considering that 38,500 Indians live in British Columbia. During the last few years, reservations were allotted to each tribe and the rest of the land declared government land. Now, the Indians of the coast are not migratory, but claim to be autochthonous in their several districts. All tribes, from Puget Sound to Alaska, believe that the Son of God gave every gens a piece of land which they consider their personal property. In confining the tribes to reservations, the single man feels that his property has been taken from him without equivalent compensation. Treaties have not been made according to these facts with every gens, as these ethnological facts are unknown to many of the officers, and therefore the Indians feel as though they were treated unjustly.

The second reason for the discontent among the Indians is a law that was passed, some time ago, forbidding the celebrations of festivals. The so-called *potlatch* of all these tribes hinders the single families from accumulating wealth. It is the great desire of every chief and even of every man to collect a large amount of property, and then to give a great *potlatch*, a feast in which all is distributed among his friends, and, if possible, among the neighboring tribes. These feasts are so closely connected with the religious ideas of the natives, and regulate their mode of life to such an extent, that the Christian tribes near Victoria have not given them up. Every present received at a *potlatch* has to be returned at another *potlatch*, and a man who would not give his feast in due time would be considered as not paying his debts. Therefore the law is not a good one, and can not be enforced without causing general discontent. Besides, the Government is unable to enforce it. The settlements are so numerous, and the Indian agencies so large, that there is nobody to prevent the Indians doing whatsoever they like.

The efforts of the Canadian Government to introduce agriculture are likewise not very successful. It is true that in some districts the extent of farming-land is considerable. But the Indian does not want to till the soil. The sea yields fish and seals; the woods furnish roots, berries, and deer; and the articles of European manufacture which he wants are either obtained by barter or by a few weeks of work in the canneries, saw-mills, hop-fields, or on ships. The industries to which the Indians of that region take readily are carpentry, canning salmon, etc.; and the introduction of proper methods of fishing and canning fish, of lumbering, and of trades connected with it, would be more probable to lead to satisfactory results than that of agriculture.

EVOLUTION: WHAT IT IS NOT, AND WHAT IT IS.

EVERYBODY nowadays talks about evolution. Like electricity, the cholera-germ, woman's rights, the great mining boom, and the Eastern question, it is "in the air." It pervades society everywhere with its subtile essence; it infects small talk with its familiar catchwords and its slang phrases; it even permeates that last stronghold of rampant Philistinism, the third leader in the penny papers. Everybody believes he knows all about it, and discusses it as glibly in his every-day conversation as he discusses the points of race-horses he has never seen, the charms of peeresses he has never spoken to, and the demerits of authors he has never read. Everybody is aware, in a dim and nebulous semi-conscious fashion, that it was all invented by the late Mr. Darwin, and reduced to a system by Mr. Herbert Spencer, don't you know, and a lot more of those scientific fellows. It is generally understood in the best-informed circles that evolutionism consists for the most part in a belief about Nature at large essentially similar to that applied by Topsy to her own origin and early history.

It is conceived, in short, that most things "growed." Especially is it known that, in the opinion of the evolutionists as a body, we are all of us ultimately descended from men with tails, who were the final offspring and improved edition of the common gorilla. That, very briefly put, is the popular conception of the various points in the great modern evolutionary programme.

It is scarcely necessary to inform the intelligent reader, who, of course, differs fundamentally from that inferior class of human beings known to all of us in our own minds as "other people," that almost every point in the catalogue thus briefly enumerated is a popular fallacy of the wildest description. Mr. Darwin did not invent evolution any more than George Stephenson invented the steam-engine, or Mr. Edison the electric telegraph. We are not descended from men with tails any more than we are descended from Indian elephants. There is no evidence that we have anything in particular more than the remotest fiftieth cousinship with our poor relation the West African gorilla. Science is not in search of a "missing link"; few links are anywhere missing, and those are for the most part wholly unimportant ones. If we found the imaginary link in question, he would not be a monkey, nor yet in any way a tailed man. And so forth generally through the whole list of popular beliefs and current fallacies as to the real meaning of evolutionary teaching. Whatever people think evolutionary is for the most part a pure parody of the evolutionist's opinion.

But a more serious error than all these pervades what we may call the drawing-room view of the evolutionist theory. So far as Society with a big initial is concerned, evolutionism first began to be talked about, and therefore known (for society does not read, it listens, or rather it overhears and catches fragmentary echoes), when Darwin published his "Origin of Species." That great book consisted simply of a theory as to the causes which led to the distinctions of kind between plants and animals. With evolution at large it had nothing to do; it took for granted the origin of sun, moon, and stars, planets and comets, the earth and all that in it is, the sea and the dry land, the mountains and the valleys, nay, even life itself in the crude form, everything, in fact, save the one point of the various types and species of living beings. Long before Darwin's book appeared, evolution had been a recognized force in the moving world of science and philosophy. Kant and Laplace had worked out the development of suns and earths from white-hot star-clouds. Lyell had worked out the evolution of the earth's surface to its present highly complex geographical condition. Lamarck had worked out the descent of plants and animals from a common ancestor by slow modification. Herbert Spencer had worked out the growth of mind from its simplest beginnings to its highest outcome in human thought.

But society, like Gallio, cared nothing for all these things. The evolutionary principles had never been put into a single big book, asked for at Mudie's, and permitted to lie on the drawing-room table side by side with the last new novel and the last fat volume of scandalous court memoirs. Therefore society ignored them, and knew them not; the word evolution scarcely entered at all as yet into its polite and refined dinner-table vocabulary. It recognized only the "Darwinian theory," "natural selection," "the missing link," and the belief that men were merely monkeys who had lost their tails, presumably by sitting upon them. To the world at large, that learned Mr. Darwin had invented and patented the entire business, including descent with modification, if such notions ever occurred at all to the world-at-large's speculative intelligence.

Now, evolutionism is really a thing of far deeper growth and older antecedents than this easy, superficial, drawing-room view would lead us to imagine. It is a very ancient and respectable theory, indeed, and it has an immense variety of minor developments. I am not going to push it back, in the fashionable modern scientific manner, to the vague and indefinite hints in our old friend Lucretius. The great original Roman poet—the only original poet in the Latin language—did indeed hit out for himself a very good rough working sketch of a sort of nebulous and shapeless evolutionism. It was bold, it was consistent, for its time it was wonderful. But Lucretius's philosophy, like all the philosophies of the older world, was a mere speculative idea, a fancy picture of the development of things, not dependent upon observation of facts at all, but wholly evolved, like the German thinker's camel, out of its author's own pregnant inner consciousness. The Roman poet would no doubt have built an excellent superstructure if he had only possessed a little straw to make his bricks of. As it was, however, scientific brick-making being still in its infancy, he could only construct in a day a shadowy Aladdin's palace of pure fanciful Epicurean phantasms, an imaginary world of imaginary atoms, fortuitously concurring out of void chaos into an orderly universe, as though by miracle. It is not thus that systems arise which regenerate the thought of humanity; he who would build for all time must make sure first of a solid foundation, and then use sound bricks in place of the airy nothings of metaphysical speculation.

It was in the last century that the evolutionary idea really began to take form and shape in the separate conceptions of Kant, Laplace, Lamarck, and Erasmus Darwin. These were the true founders of our modern evolutionism. Charles Darwin and Herbert Spencer were the Joshuas who led the chosen people into the land which more than one venturous Moses had already dimly descried afar off from the Pisgah top of the eighteenth century.

Kant and Laplace came first in time, as astronomy comes first in logical order. Stars and suns, and planets and satellites, necessarily precede in development plants and animals. You can have no cabbages without a world to grow them in. The science of the stars was therefore reduced to comparative system and order, while the sciences of life, and mind, and matter were still a hopeless and inextricable muddle. It was no wonder, then, that the evolution of the heavenly bodies should have been clearly apprehended and definitely formulated while the evolution of the earth's crust was still imperfectly understood, and the evolution of living beings was only tentatively and hypothetically hinted at in a timid whisper.

In the beginning, say the astronomical evolutionists, not only this world, but all the other worlds in the universe, existed potentially, as the poet justly remarks, in "a haze of fluid light," a vast nebula of enormous extent and almost inconceivable material thinness. The world arose out of a sort of primitive world-gruel. The matter of which it was composed was gas, of such an extraordinary and unimaginable gasiness that millions of cubic miles of it might easily be compressed into a common antibilious pill-box. The pill-box itself, in fact, is the net result of a prolonged secular condensation of myriads of such enormous cubes of this primeval matter. Slowly setting around common centers, however, in anticipation of Sir Isaac Newton's gravitative theories, the fluid haze gradually collected into suns and stars, whose light and heat are presumably due to the clashing together of their component atoms as they fall perpetually toward the central mass. Just as in a burning candle the impact of the oxygen atoms in the air against the carbon and hydrogen atoms in the melted and rarefied wax or tallow produces the light and heat of the flame, so in nebula or sun the impact of the various gravitating atoms one against the other produces the light and heat by whose aid we are enabled to see and know those distant bodies. The universe, according to this now fashionable nebular theory, began as a single vast ocean of matter of immense tenuity, spread all alike over all space as far as nowhere, and comparatively little different within itself when looked at side by side with its own final historical outcome. In Mr. Spencer's perspicuous phrase, evolution in this aspect is a change from the homogeneous to the heterogeneous, from the incoherent to the coherent, and from the indefinite to the definite condition. Difficult words at first to apprehend, no doubt, and therefore to many people, as to Mr. Matthew Arnold, very repellent, but full of meaning, lucidity, and suggestiveness, if only we once take the trouble fairly and squarely to understand them.

Every sun and every star thus formed is forever gathering in the hem of its outer robe upon itself, forever radiating off its light and heat into surrounding space, and forever growing denser and colder as it sets slowly toward its center of gravity. Our own sun and solar system may be taken as good typical working examples of how the stars thus constantly shrink into smaller and ever smaller dimensions around their own fixed center. Naturally, we know more about our own solar system than about any other in our own universe, and it also possesses for us a greater practical and personal interest than any outside portion of the galaxy. Nobody can pretend to be profoundly immersed in the internal affairs of Sirius or of Alpha Centauri. A fiery revolution in the belt of Orion would affect us less than a passing finger-ache in a certain single terrestrial baby of our own household. Therefore I shall not apologize in any way for leaving the remainder of the sidereal universe to its unknown fate, and concentrating my attention mainly on the affairs of that solitary little, out-of-the-way second-rate system, whereof we form an inappreciable portion. The matter which now composes the sun and its attendant bodies (the satellites included) was once spread out, according to Laplace, to at least the farthest orbit of the outermost planet—that is to say, so far as our present knowledge goes, the planet Neptune. Of course, when it was expanded to that immense distance, it must have been very thin indeed, thinner than our clumsy human senses can even conceive of. An American would say, "too thin": but I put Americans out of court at once as mere irreverent scoffers. From the orbit of Neptune, or something outside it, the faint and cloud-like mass which bore within it Cæsar and his fortunes, not to mention the remainder of the earth and the solar system, began slowly to converge and gather itself in, growing denser and denser but smaller and smaller as it gradually neared its existing dimensions. How long a time it took to do it is for our present purpose relatively unimportant: the cruel physicists will only let us have a beggarly hundred million years or so for the process, while the grasping and extravagant evolutionary geologists beg with tears for at least double or even ten times that limited period. But at any rate it has taken a good long while, and, as far as most of us are personally concerned, the difference of one or two hundred millions, if it comes to that, is not really at all an appreciable one.

As it condensed and lessened toward its central core, revolving rapidly on its great axis, the solar mist left behind at irregular intervals concentric rings or belts of cloud-like matter, cast off from its equator; which belts, once more undergoing a similar evolution on their own account, have hardened round their private centers of gravity into Jupiter or Saturn, the Earth or Venus. Round these again, minor belts or rings have sometimes formed, as in Saturn's girdle of petty satellites; or subsidiary planets, thrown out into space, have circled round their own primaries, as the moon does around this sublunary world of ours. Meanwhile, the main central mass of all, retreating ever inward as it dropped behind it these occasional little reminders of its temporary stoppages, formed at last the sun itself, the main luminary of our entire system. Now, I won't deny that this primitive Kantian and Laplacian evolutionism, this nebular theory of such exquisite concinnity, here reduced to its simplest terms and most elementary dimensions, has received many hard knocks from later astronomers, and has been a good deal bowled over, both on mathematical and astronomical grounds, by recent investigators of nebulæ and meteors. Observations on comets and on the sun's surface have lately shown that it contains in all likelihood a very considerable fanciful admixture. It isn't more than half true; and even the half now totters in places. Still, as a vehicle of popular exposition the crude nebular hypothesis in its rawest form serves a great deal better than the truth, so far as yet known, on the good old Greek principle of the half being often more than the whole. The great point which it impresses on the mind is the cardinal idea of the sun and planets, with their attendant satellites, not as turned out like manufactured articles, ready made, at measured intervals, in a vast and deliberate celestial orrery, but as due to the slow and gradual working of natural laws, in accordance with which each has assumed by force of circumstances its existing place, weight, orbit, and motion.

The grand conception of a gradual becoming, instead of a sudden making, which Kant and Laplace thus applied to the component bodies of the universe at large, was further applied by Lyell and his school to the outer crust of this one particular petty planet of ours. While the astronomers went in for the evolution of suns, stars, and worlds, Lyell and his geological brethren went in for the evolution of the earth's surface. As theirs was stellar, so his was mundane. If the world began by being a red-hot mass of planetary matter in a high state of internal excitement, boiling and dancing with the heat of its emotions, it gradually cooled down with age and experience, for growing old is growing cold, as every one of us in time, alas! discovers. As it passed from its fiery and volcanic youth to its staider and soberer middle age, a solid crust began to form in filmy fashion upon its cooling surface. The aqueous vapor that had floated at first as steam around its heated mass condensed with time into a wide ocean over the now hardened shell. Gradually this ocean shifted its bulk into two or three main bodies that sank into hollows of the viscid crust, the precursors of Atlantic, Pacific, and the Indian Seas. Wrinklings of the crust, produced by the cooling and consequent contraction, gave rise at first to baby mountain-ranges, and afterward to the earliest rough drafts of the still very vague and sketchy continents. The world grew daily more complex and more diverse; it progressed, in accordance with the Spencerian law, from the homogeneous to the heterogeneous, and so forth, as aforesaid, with delightful regularity.

At last, by long and graduated changes, seas and lands, peninsulas and islands, lakes and rivers, hills and mountains, were wrought out by internal or external energies on the crust thus generally fashioned. Evaporation from the oceans gave rise to clouds and rain and hailstorms; the water that fell upon the mountain-tops cut out the valleys and river-basins; rills gathered into brooks, brooks into streams,

streams into primeval Niles, and Amazons, and Mississippis. Volcanic forces uplifted here an Alpine chain, or depressed there a deep-sea hollow. Sediment washed from the hills and plains, or formed from countless skeletons of marine creatures, gathered on the sinking bed of the ocean as soft ooze, or crumbling sand, or thick mud, or gravel and conglomerate. Now upheaved into an elevated table-land, now slowly carved again by rain and rill into valley and water-shed, and now worn down once more into the mere degraded stump of a plateau, the crust underwent innumerable changes, but almost all of them exactly the same in kind, and mostly in degree, as those we still see at work imperceptibly in the world around us. Rain washing down the soil; weather crumbling the solid rock; waves dashing at the foot of the cliffs; rivers forming deltas at their barred mouths; shingle gathering on the low spits; floods sweeping before them the country-side; ice grinding ceaselessly at the mountain-top; peat filling up the shallow lake—these are the chief factors which have gone to make the physical world as we now actually know it. Land and sea, coast and contour, hill and valley, dale and gorge, earth-sculpture generally—all are due to the ceaseless interaction of these separately small and unnoticeable causes, aided or retarded by the slow effects of elevation or depression from the earth's shrinkage toward its own center. Geology, in short, has shown us that the world is what it is, not by virtue of a single sudden creative act, nor by virtue of successive terrible and recurrent cataclysms, but by virtue of the slow continuous action of causes still always equally operative.

Evolution in geology leads up naturally to evolution in the science of life. If the world itself grew, why not also the animals and plants that inhabit it? Already in the eager active eighteenth century this obvious idea had struck in the germ a large number of zoölogists and botanists, and in the hands of Lamarck and Erasmus Darwin it took form as a distinct and elaborate system of organic evolution. Buffon had been the first to hint at the truth; but Buffon was an eminently respectable nobleman in the dubious days of the tottering monarchy, and he did not care personally for the Bastile, viewed as a place of permanent residence. In Louis Quinze's France, indeed, as things then went, a man who offended the orthodoxy of the Sorbonne was prone to find himself shortly ensconced in free quarters, and kept there for the term of his natural existence without expense to his heirs or executors. So Buffon did not venture to say outright that he thought all animals and plants were descended one from the other with slight modifications; that would have been wicked, and the Sorbonne would have proved its wickedness to him in a most conclusive fashion by promptly getting him imprisoned or silenced. It is so easy to confute your opponent when you are a hundred strong and he is one weak unit! Buffon merely said, therefore, that if we didn't know the contrary to be the case by sure warrant, we might easily have concluded (so fallible is our reason) that animals always varied slightly, and that such variations, indefinitely accumulated, would suffice to account for almost any amount of ultimate difference. A donkey might thus have grown into a horse, and a bird might have developed from a primitive lizard. Only we know it was quite otherwise! A quiet hint from Buffon was as good as a declaration from many less knowing or suggestive people. All over Europe, the wise took Buffon's hint for what he meant it; and the unwise blandly passed it by as a mere passing little foolish vagary of that great ironical writer and thinker.

Erasmus Darwin, the grandfather of his grandson, was no fool; on the contrary, he was the most far-sighted man of his day in England; he saw at once what Buffon was driving at; and he worked out "Mr. Buffon's" half-concealed hint to all its natural and legitimate conclusions. The great count was always plain Mr. Buffon to his English contemporary. Life, said Erasmus Darwin nearly a century since, began in very minute marine forms, which gradually acquired fresh powers and larger bodies, so as imperceptibly to transform themselves into different creatures. Man, he remarked, anticipating his descendant, takes rabbits or pigeons, and alters them almost to his own fancy, by immensely changing their shapes and colors. If man can make a pouter or a fantail out of the common sort, if he can produce a piebald lop-ear from the brown wild rabbit, if he can transform Dorkings into Black Spanish, why can not Nature, with longer time to work in, and endless lives to try with, produce all the varieties of vertebrate animals out of one single common ancestor? It was a bold idea of the Lichfield doctor—bold, at least, for the times he lived in—when Sam Johnson was held a mighty sage, and physical speculation was regarded askance as having in it a dangerous touch of the devil. But the Darwins were always a bold folk, and had the courage of their opinions more than most men. So even in Lichfield, cathedral city as it was, and in the politely somnolent eighteenth century, Erasmus Darwin ventured to point out the probability that quadrupeds, birds, reptiles, and men were all mere divergent descendants of a single similar original form, and even that "one and the same kind of living filament is and has been the cause of organic life."

The eighteenth century laughed, of course. It always laughed at all reformers. It said that Dr. Darwin was very clever, but really a most eccentric man. His "Temple of Nature," now, and his "Botanic Garden," were vastly fine and charming poems—those sweet lines, you know, about poor Eliza!—but his zoölogical theories were built of course upon a most absurd and uncertain foundation. In prose, no sensible person could ever take the doctor seriously. A freak of genius —nothing more; a mere desire to seem clever and singular. But what a Nemesis the whirligig of time has brought around with it! By a strange irony of fate, those admired verses are now almost entirely forgotten; poor Eliza has survived only as our awful example of artificial pathos; and the zoölogical heresies at which the eighteenth century shrugged its fat shoulders and dimpled the corners of its ample mouth, have grown to be the chief corner-stone of all accepted modern zoölogical science.

In the first year of the present century Lamarck followed Erasmus Darwin's lead with an open avowal that in his belief all animals and plants were really descended from one or a few common ancestors. He held that organisms were just as much the result of law, not of miraculous interposition, as suns and worlds and all the natural phenomena around us generally. He saw that what naturalists call a species differs from what naturalists call a variety merely in the way of being a little more distinctly marked, a little less like its nearest congeners elsewhere. He recognized the perfect gradation of forms by which in many cases one species after another merges into the next on either side of it. He observed the analogy between the modifications induced by man and the modifications induced by Nature. In fact, he was a thoroughgoing and convinced evolutionist, holding every salient opinion which society still believes to have been due to the works of Charles Darwin. In one point only, a minor point to outsiders, though a point of cardinal importance to the inner brotherhood of evolutionism, he did not anticipate his more famous successor. He thought organic evolution was wholly due to the direct action of surrounding circumstances, to the intercrossing of existing forms, and above all to the actual efforts of animals themselves. In other words, he had not discovered natural selection, the cardinal idea of Charles Darwin's epoch-making book. For him, the giraffe had acquired its long neck by constant reaching up to the boughs of trees; the monkey had acquired its opposable thumb by constant grasping at the neighboring branches; and the serpent had acquired its sinuous shape by constant wriggling through the grass of the meadows. Charles Darwin improved upon all that by his suggestive hint of survival of the fittest, and in so far, but in so far alone, he became the real father of modern biological evolutionism.

From the days of Lamarck to the day when Charles Darwin himself published his wonderful "Origin of Species," this idea that plants and animals might really have grown, instead of having been made all of a piece, kept brewing everywhere in the minds and brains of scientific thinkers. The notions which to the outside public were startlingly new when Darwin's book took the world by storm, were old indeed to the thinkers and workers who had long been familiar with the principle of descent with modification and the speculations of the Lichfield doctor or the Paris philosopher. Long before Darwin wrote his great work, Herbert Spencer had put forth in plain language every idea which the drawing-room biologists attributed to Darwin. The supporters of the development hypothesis, he said seven years earlier—yes, he called it the "development hypothesis" in so many words—"can show that modification has effected and is effecting great changes in all organisms, subject to modifying influences." They can show, he goes on (if I may venture to condense so great a thinker), that any existing plant or animal, placed under new conditions, begins to undergo adaptive changes of form and structure; that in successive generations these changes continue, till the plant or animal acquires totally new habits; that in cultivated plants and domesticated animals changes of the sort habitually occur; that the differences thus caused, as, for example, in dogs, are often greater than those on which species in the wild state are founded, and that throughout all organic nature there *is* at work a modifying influence of the same sort as that which they believe to have caused the differences of species—"an influence which, to all appearance, would produce in the millions of years, and under the great variety of conditions which geological records imply, any amount of change." What is this but pure Darwinism, as the drawing-room philosopher still understands the word? And yet it was written seven years before Darwin published the "Origin of Species."

The fact is, one might draw up quite a long list of Darwinians before Darwin. Here are a few of them—Buffon, Lamarck, Goethe, Oken, Bates, Wallace, Lecoq, Von Baer, Robert Chambers, Matthew, and Herbert Spencer. Depend upon it, no one man ever yet of himself discovered anything. As well say that Luther made the German Reformation, that Leonardo made the Italian Renaissance, or that Robespierre made the French Revolution, as say that Charles Darwin, and Charles Darwin alone, made the evolutionary movement, even in the restricted field of life only. A thousand predecessors worked up toward him; a thousand contemporaries helped to diffuse and to confirm his various principles.

Charles Darwin added to the primitive evolutionary idea the special notion of natural selection. That is to say, he pointed out that, while plants and animals vary perpetually and very indefinitely, all the varieties so produced are not equally adapted to the circumstances of the species. If the variation is a bad one, it tends to die out, because every point of disadvantage tells against the individual in the struggle for life. If the variation is a good one, it tends to persist, because every point of advantage similarly tells in the individual's favor in that ceaseless and viewless battle. It was this addition to the evolutionary concept, fortified by Darwin's powerful advocacy of the general principle of descent with modification, that won over the whole world to the "Darwinian theory." Before Darwin, many men of science were evolutionists; after Darwin, all men of science became so at once, and the rest of the world is rapidly preparing to follow their leadership.

As applied to life, then, the evolutionary idea is briefly this—that plants and animals have all a natural origin from a single primitive living creature, which was itself the product of light and heat acting on the special chemical constituents of an ancient ocean. Starting from that single early form, they have gone on developing ever since, from the homogeneous to the heterogeneous, assuming ever more varied shapes, till at last they have reached their present enormous variety of tree and shrub, and herb and sea-weed, of beast and bird, and fish and creeping insect. Evolution throughout has been one and continuous, from nebula to sun, from gas-cloud to planet, from early jelly-speck to man or elephant. So at least evolutionists say—and of course they ought to know most about it.

But evolution, according to the evolutionists, does not even stop there. Psychology as well as biology has also its evolutionary explanation: mind is concerned as truly as matter. If the bodies of animals are evolved, their minds must be evolved likewise. Herbert Spencer and his followers have been mainly instrumental in elucidating this aspect of the case. They have shown, or they have tried to show (for I don't want to dogmatize on the subject), how mind is gradually built up from the simplest raw elements of sense and feeling; how emotions and intellect slowly arise; how the action of the environment on the organism begets a nervous system of ever greater and greater complexity, culminating at last in the brain of a Newton, a Shakespeare, or a Mendelssohn. Step by step, nerves have built themselves up out of the soft tissues as channels of communication between part and part. Sense-organs of extreme simplicity have first been formed on the outside of the body, where it comes most into contact with external nature. Use and wont have fashioned them through long ages into organs of taste and smell and touch; pigment-spots, sensitive to light or shade, have grown by infinite gradations into the human eye or into the myriad facets of bee and beetle; tremulous nerve-ends, responsive sympathetically to waves of sound, have tuned themselves at last into a perfect gamut in the developed ear of men and mammals. Meanwhile corresponding percipient centers have grown up in the brain, so that the colored picture flashed by an external scene upon the eye is telegraphed from the sensitive mirror of the retina, through the many-stranded cable of the optic nerve, straight up to the appropriate headquarters in the thinking brain. Stage by stage the continuous process has gone on unceasingly, from the jelly-fish with its tiny black specks of eyes, through infinite steps of progression, induced by ever-widening intercourse with the outer world, to the final outcome in the senses and the emotions, the intellect and the will, of civilized man. Mind begins as a vague consciousness of touch or pressure on the part of some primitive, shapeless, soft creature; it ends as an organized and co-ordinated reflection of the entire physical and psychical universe on the part of a great cosmical philosopher.

Last of all, like diners-out at dessert, the evolutionists take to politics. Having shown us entirely to their own satisfaction the growth of suns, and systems, and worlds, and continents, and oceans, and plants, and animals, and minds, they proceed to show us the exactly analogous and parallel growth of communities, and nations, and languages, and religions, and customs, and arts, and institutions, and literatures. Man, the evolving savage, as Tylor, Lubbock, and others have proved for us, slowly putting off his brute aspect derived from his early ape-like ancestors, learned by infinitesimal degrees the use of fire, the mode of manufacturing stone hatchets and flint arrow-heads, the earliest beginnings of the art of pottery. With drill or flint he became the Prometheus to his own small heap of sticks and dry leaves among the Tertiary forests. By his nightly camp-fire he beat out gradually his excited gesture-language and his oral speech. He tamed the dog, the horse, the cow, the camel. He taught himself to hew small clearings in the woodland, and to plant the banana, the yam, the bread-fruit, and the cocoanut. He picked and improved the seeds of his wild cereals till he made himself from grass-like grains his barley, his oats, his wheat, his Indian corn. In time, he dug out ore from mines, and learned the use first of gold, next of silver, then of copper, tin, bronze, and iron. Side by side with these long secular changes, he evolved the family, communal or patriarchal, polygamic or monogamous. He built the hut, the house, and the palace. He clothed or adorned himself first in skins and leaves and feathers; next in woven wool and fiber; last of all in purple and fine linen, and fared sumptuously every day. He gathered into hordes, tribes, and nations; he chose himself a king, gave himself laws, and built up great empires in Egypt, Assyria, China, and Peru. He raised him altars, Stonehenges and Karnaks. His picture-writing grew into hieroglyphs and cuneiforms, and finally emerged, by imperceptible steps, into alphabetic symbols, the raw material of the art of printing. His dug-out canoe culminates in the ironclad and the Great Eastern; his boomerang and sling-stone in the Woolwich infant; his boiling pipkin and his wheeled car in the locomotive-engine; his picture-message in the telephone and the Atlantic cable. Here, where the course of evolution has really been most marvelous, its steps have been all more distinctly historical; so that nobody now doubts the true descent of Italian, French, and Spanish from provincial Latin, or the successive growth of the trireme, the Great Harry, the Victory, and the Minotaur from the coracles or proas of prehistoric antiquity.

The grand conception of the uniform origin and development of all things, earthly or sidereal, thus summed up for us in the one word evolution, belongs by right neither to Charles Darwin nor to any other single thinker. It is the joint product of innumerable workers, all working up, though some of them unconsciously, toward a grand final unified philosophy of the cosmos. In astronomy, Kant, Laplace, and the Herschels; in geology, Hutton, Lyell, and the Geikies; in biology, Buffon, Lamarck, the Darwins, Huxley, and Spencer; in psychology, Spencer, Romanes, Sully, and Ribot; in sociology, Spencer, Tylor, Lubbock, and De Mortillet—these have been the chief evolutionary teachers and discoverers. But the use of the word evolution itself, and the establishment of the general evolutionary theory as a system of philosophy applicable to the entire universe, we owe to one man alone—Herbert Spencer. Many other minds—from Galileo and Copernicus, from Kepler and Newton, from Linnæus and Tournefort, from D'Alembert and Diderot, nay, even, in a sense, from Aristotle and Lucretius—had been piling together the vast collection of raw material from which that great and stately superstructure was to be finally edified. But the architect who placed each block in its proper niche, who planned and designed the whole elevation, who planted the building firmly on the rock and poised the coping-stone on the topmost pinnacle, was the author of the "System of Synthetic Philosophy," and none other. It is a strange proof of how little people know about their own ideas, that, among the thousands who talk glibly every day of evolution, not ten per cent are probably aware that both word and conception are alike due to the commanding intelligence and vast generalizing power of Herbert Spencer.—*Cornhill Magazine.*

WEATHER-PROGNOSTICS.*

By the HON. RALPH ABERCROMBY.

FROM classic times, down to the commencement of this century, it can hardly be said that this branch of meteorology made any advance. Few, if any, new prognostics had been discovered, and neither their physical explanation nor their meteorological significance had been found out. But about eighty years ago some physical explanations were given. It was found that the air always contained a certain quantity of uncondensed vapor, and means were invented for measuring this amount accurately. From this, the nature and conditions of the formation of dew were discovered, and also that before many cases of rain the air became more charged with vapor. This latter fact gave the explanation of several rain-prognostics. For instance, when walls sweat, stones grow black, and clouds form on hill-tops, rain may be expected almost all the world over.

But even when these reasons had been discovered, the science flagged. A large number of rain-prognostics could not be shown by any means to depend on an increase of moisture, and, as vapor can not grow in the air, some explanation was needed to account for its variable quantity. And even when, in a general way, the prognostic had been explained, no clew whatever had been found for what we may

* Abridged from "Weather," by the Hon. Ralph Abercromby. "International Scientific Series," volume lviii. New York: D. Appleton & Co., 1888.

call the meteorological significance. What was the relation of the damp to the rain? Why did the prognostic sometimes fail? Why are there many rain-prognostics associated with a tolerably dry air? Why is not all rain preceded by the same set of prognostics? To all these questions no answer could be given. Prognostics had almost fallen into disrepute; they were considered no part of science, and had been supposed to be only suitable for rustics and sailors.

So the subject remained till the introduction of synoptic charts. Then it was soon seen that in temperate regions the broad features of weather depend on the shape of the isobaric lines, and later on it was shown—the author believes, mainly by himself—that nearly all prognostics have a definite place in some shape of isobars, and that all the above questions, formerly insoluble, receive a ready explanation. It has also been demonstrated that prognostics can never be superseded for use on board ship, and that even in the highest developments of weather-forecasting by means of electric telegraph, prognostics often afford most valuable information. But before we attempt to explain how this is done, we must introduce the reader into the elements of synoptic meteorology.

Synoptic meteorology is that part of the science which deals with the results obtained by constructing synoptic charts. Formerly, all meteorology was deduced from the changes which took place in the instrumental readings at any one place during any interval of time, say one day. For instance, a great deal had been discovered as to the connection between a falling or rising barometer and the accompanying rain or wind. Synoptic charts, on the contrary, are constructed by taking the readings of any instrument (say the barometer), or any observations on the sky or the weather (say where rain is falling, or cloud or blue sky is seen), at a large number of places at the same moment (say 8 A. M. at Greenwich). A map of the area or district from which the observations have been received is then taken, the barometer-readings are marked down over their respective places, and then lines are drawn through all the stations where the pressure is equal; for instance, through all the places where the pressure is 29·9 inches (760 mm.), and again at convenient intervals, generally of about two tenths of an inch, say 29·7 inches (755 mm.), 29·5 inches (750 mm.), and so on. These lines are called isobaric lines, or more shortly isobars—that is, lines of equal atmospheric weight or pressure. This method of showing the distribution of pressure by isobars is exactly analogous to that of marking out hills and valleys by means of contour-lines of equal altitude.

Similarly, the places which report rain, cloud, blue sky, etc., are marked with convenient symbols to denote these phenomena. Then arrows are placed over each observing station, with a number of barbs and feathers which roughly indicate the force of the wind. By an international convention, the arrows always fly with the wind;

that is to say, they do not face the wind like the pointer of a wind-vane.

When all this is done, we can see at a glance whether or how wind, rain, cloud, and blue sky are connected with the shape of the isobars. In fact, a synoptic chart gives us, as it were, a bird's-eye view of the weather at the particular moment for which the chart is constructed, over the whole district from which reports have been received. Suppose, now, that after an interval of twenty-four hours another chart is constructed from observations taken over the same area, then we generally find that the shape of the isobars and the position of the areas of high and low pressure have considerably changed, and with them the positions of those areas where the weather is good or bad. For instance, suppose that at 8 A. M. on one morning we find pressure low over Ireland and high over Denmark, with rain over Ireland, cloud over England, and blue sky in Denmark; and that by 8 A. M. on the following day we find that the low-pressure area has advanced to Denmark, and that a new high pressure has formed over Ireland, with rain in Denmark, broken sky in England, and blue sky in Ireland; suppose, too, that the record of the weather, say in London, for those twenty-four hours had been as follows—cloudy sky, followed by rain, after which the sky broke—how can an inspection of the two charts help us to explain the weather as observed in London during that day? Our bird's-eye view would show that the rain-area which lay over Ireland in the morning had drifted during the day over England, including London, and covered Denmark by next morning. It would also tell us that the position of the rain was identified with and moved along with the low pressure. This is the fundamental idea of all synoptic meteorology, but one which can only be thoroughly grasped after a considerable experience in tracing actual cases.

Such, then, is a synoptic chart. Many thousands have been constructed for all parts of the world, and by comparing them the following important generalizations have been arrived at:

1. That in general the configuration of the isobars takes one of seven well-defined forms.

2. That, independent of the shape of the isobars, the wind always takes a definite direction relative to the trend of these lines, and the position of the nearest area of low pressure.

3. That the velocity of the wind is always nearly proportional to the closeness of the isobars.

4. That the weather—that is to say, the kind of cloud, rain, fog, etc.—at any moment depends on the shape, and not the closeness, of the isobars, some shapes being associated with good and others with bad weather.

5. That the regions thus mapped out by the isobars were constantly shifting their position, so that changes of weather were caused by the drifting past of these areas of good or bad weather, just as on a small

scale rain falls as a squall drives by. The motion of these areas was found to follow certain laws, so that forecasting weather-changes in advance became a possibility.

6. That in the temperate zones sometimes, and habitually in the tropics, rain fell without any appreciable change in the isobars, though the wind conformed more regularly to the general law of these lines. This class of rainfall will be called "non-isobaric rain."

In Fig. 1 we give in a diagrammatic form the broad features only

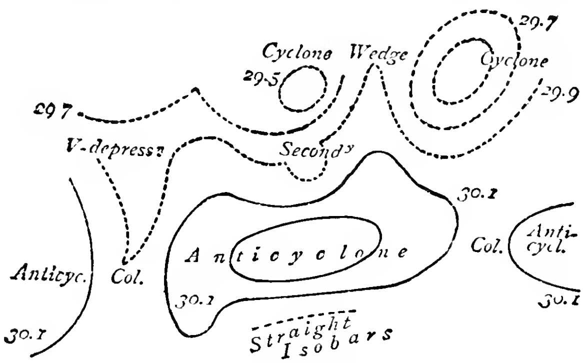


FIG. 1.—THE SEVEN FUNDAMENTAL SHAPES OF ISOBARS.

of the distribution of pressure over the North Atlantic, Europe, and the eastern portions of the United States on February 27, 1865. Coast-lines are omitted, so as not to confuse the eye, so also are lines of latitude and longitude; but the foot-note at the bottom of the figure represents the equator, and the top of the diagram would be on the Arctic Circle. All pressures of and under 29·9 inches (760 mm.) are shown with dotted lines, so that the eye sees at a glance the broad distribution of high or low pressure. The whole seven fundamental shapes of isobars will be found there.

Looking at the top of the diagram, we see two nearly circular areas of low pressure, round which the isobars are rather closely packed. Such areas, or rather the configurations of isobars which inclose them, are called "cyclones," from a Greek word meaning a circle, because they are nearly circular, and, as we shall see presently, the wind blows nearly in a circle round their center. Just south of one of the cyclones, the isobar of 29·9 inches (760 mm.) forms a small sort of nearly circular loop, inclosing lower pressure; this is called a "secondary cyclone," because it is usually secondary or subsidiary to the primary cyclones above described. Farther to the left the same isobar of 29·9 inches bends itself into the shape of the letter V, also inclosing low pressure; this is called a "V-shaped depression," or, shortly, a "V." Between the two cyclones the isobar of 29·9 inches projects upward, like a wedge or an inverted letter V, but this time incloses high pressure; this shape of lines is called a "wedge." Below all these we see an oblong area of high pressure, round which the isobars are very far apart; this is called an "anticyclone," because it is the opposite to a cyclone in everything—wind, weather, pressure, etc. Between every two anticyclones we find a furrow, neck, or "col" of low pressure analogous to the *col* which forms a pass between two adjacent mountain-peaks. Lastly, as marked in the lower edge of the diagram, isobars sometimes run straight, so that they do not include any kind of area, but represent a barometric slope analogous to the sloping sides of a long hill. The cyclones, secondaries, V's, and wedges are usually moving toward the east at the rate of about twenty miles an hour; but the anticyclones, on the contrary, are usually stationary for days and sometimes for months together. We should also note that, though the general principles of prognostics and the broad features of the weather in each of these shapes of isobars are the same all over the world, the minute details which we intend to give now apply to Great Britain and the temperate zones only.

We will now take the cyclone separately, and detail the kind of wind and weather which is experienced in different parts of it. In Fig. 2 we give a diagram on which we have written in words the

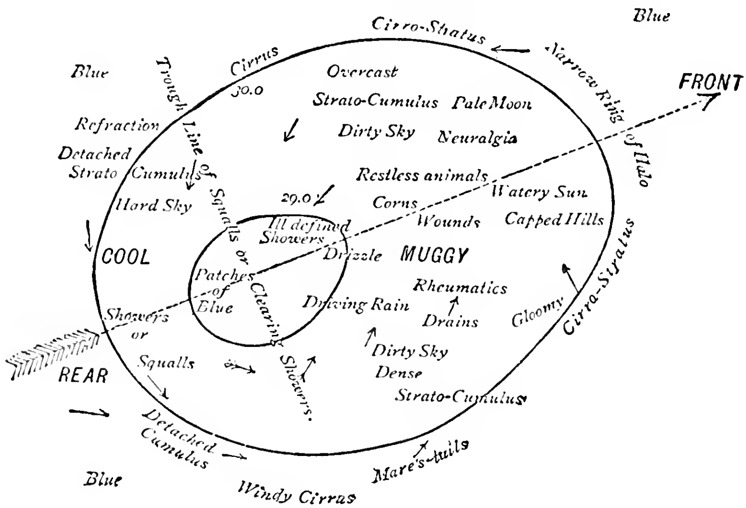


Fig. 2.—Cyclone Prognostics.

kind of weather which would be found in every portion of a typical cyclone; arrows also show the direction of the wind relative to the isobars and to the center. First let us look at the isobars. We find that they are oval, and that they are not quite concentric, but the center of the inner one we will call the center of the cyclone. Now observe the numbers attached to the isobars; the outer one is 30·0 inches (762 mm.), the inner one 29·0 inches (737 mm.). But suppose the outer one was the same, but the inner one was 29·5 (755 mm.).

We should then have two cyclones, differing in nothing but depth; that is, in the closeness of the isobars, or the steepness of the barometric slope. Observation has shown that under these circumstances the general character of the weather and the direction of the wind everywhere would be the same; the only difference would be that the wind would blow a hard gale in the first and only a moderate breeze in the second case; and that what was a sharp squall in the one would be a quiet shower in the other. This is one of the fundamental principles of synoptic meteorology—that the character of the weather and direction of the wind depend entirely on the shape of the isobars, while the force of the wind and intensity of the character of the weather depend only on the closeness of the isobars.

The difference in the details of the weather in a cyclone, or any other isobaric shape which are due to difference in the steepness of the isobars, is called a difference in the intensity of the weather. Hence, when we speak of a cyclone as being intense, we mean that it has steep isobars somewhere. When we come to talk about the general sequence of weather from day to day, we shall find that *there is no difference between the cyclones which cause storms and those which cause ordinary weather except intensity.* This is another of the fundamental principles of meteorology.

Returning now to our cyclone, the whole of the portion in front of the center facing the direction toward which it moves is called its front, and the whole of this portion may obviously be divided into a right and left front. The other side of the center is, of course, the rear of the cyclone. Then, as the whole cyclone moves along its course, it is evident that the barometer will be falling more or less at every portion of the front, and rising more or less everywhere in the rear, so that there must be a line of places somewhere across the cyclone where the barometer has touched its lowest point and is just going to rise. This line is called the "trough" of the cyclone, because if we look at the barometer-trace at any one place, the "ups" and "downs" suggest the analogy of waves, so that the lowest part of a trace may be called a "trough." Or we may look at the cyclone as a circular eddy, moving in a given direction, and so far presenting some analogy to a wave.

So far for the shape and names of the different portions of the cyclone. Now for the wind. A glance at the arrows will show that, broadly speaking, the wind rotates round the center in a direction opposite to the motion of the hands of a watch. That is to say, that in the extreme front, following the outer isobar, the wind is from the southeast; farther round, it is from the east-northeast; still farther, from the north-northwest; then from about west; and, finally, from the southwest. Then we note that in front the wind is slightly incurved toward the center, and therefore blows somewhat across the isobars, while in rear it has little or no incurvature, and blows nearly parallel to the isobars. The velocity or force of the wind will depend on the closeness of the isobars. In the diagram they are much closer set in rear than in front of the cyclone, and therefore the wind is strongest behind the center.

The weather in a cyclone is somewhat complicated. Some characteristic features depend on the position of the trough, and have nothing to do with the center. For instance, the weather and sky over the whole front of the cyclone—that is, all that lies in front of the trough—is characterized by a muggy, oppressive feel of the air, and a dirty, gloomy sky of a stratiform type, whether it is actually raining or only cloudy. On the other side, the whole of the rear is characterized by a sharp, brisk feel of the air, and a hard, firm sky of cumulus type.

But, on the contrary, other characteristic features are related to the center, and have little to do with the trough. The rotation of the wind, though slightly modified near the trough, is in the main related to the center, and the broad features of the weather in a cyclone are—a patch of rain near the center, a ring of cloud surrounding the rain, and blue sky outside the whole system. The center of the rain-area is rarely concentric with the isobars. It usually extends farther in front than in rear, and more to the south than to the north, but is still primarily related to the center.

This will be readily seen by reference to the diagram; there the drizzle and driving rain extend some distance to the right front, while almost directly behind the center patches of blue sky become visible. Thus a cyclone has, as it were, a double symmetry; that is to say, one set of phenomena, such as warmth, cloud character, etc., which are symmetrically disposed in front and rear of the trough; and another set, such as wind and rain, which are symmetrically arranged round the center. There is reason to believe that what we may call the circular symmetry of a cyclone is due to the rotation of the air, while the properties which are related to the trough are due to the forward motion of the whole system.

We have marked on the diagram the kind of weather and cloud which would be found in different parts of a cyclone. The first thing which will strike us is that the descriptive epithets applied to the sky contain the phraseology of the most familiar prognostics. At the extreme front we see marked "pale moon," "watery sun," which means that in that portion of a cyclone the moon or sun will look pale or watery through a peculiar kind of sky. But all over the world a pale moon and watery sun are known as prognostics of rain. Why are they so? The reason we can now explain. Since a cyclone is usually moving, after the front part where the sky gives a watery look to the sun has passed over the observer, the rainy portion will also have to come over him before he experiences the blue sky on the other side of the cyclone.

Suppose the cyclone stood still for a week, then the observer would see a watery sky for a week, without any rain following. Suppose the cyclone came on so far as to bring him under a watery sky, and then died out or moved in another direction, then, after seeing a watery sky, no rain would fall, but the sky would clear. The prognostic would then be said to fail, but the word is only partially applicable. The watery sky was formed and seen by the observer, because he was in the appropriate portion of the cyclone, and so far the prognostic told its story correctly—viz., that the observer was in the front of the rainy area of a cyclone. The prognostic failed in its ordinary indication because the cyclone did not move on as usual, but died out, and therefore never brought its rainy portion over the observer. This is the commonest source of the so-called failure of a rain-prognostic in Great Britain. The reason why all rain is not preceded by a watery sky is because there are other sources of rain besides a cyclone, which are preceded by a different set of weather-signs. Such is the whole theory of prognostics.

The same reasoning which applies to a watery sky holds good for every other cyclone-prognostic. We shall have explained why any prognostic portends rain when we have shown that the kind of sky or other appearance which forms the prognostic belongs to the front of the rainy portion of a cyclone. Conversely we shall have explained why any prognostic indicates finer weather when we have shown that the kind of sky belongs to the rear of a cyclone. It will be convenient, therefore, to describe the weather in different parts of a cyclone, and the appropriate prognostics together.

First, to take those prognostics which depend on qualities common to the whole front of the cyclone, viz., a falling barometer, increased warmth and damp, with a muggy, uncomfortable feel of the air, and a dirty sky.

From the increasing damp in this part of a cyclone, while the sky generally is pretty clear, cloud forms round and "caps" the tops of hills, which has given rise to numerous local sayings. The reason is that a hill always deflects the air upward. Usually the cold caused by ascension and consequent expansion is not sufficient to lower the temperature of the air below the dew-point ; but when very damp, the same amount of cooling will bring the air below the dew-point, and so produce condensation.

From the same excessive damp the following may be explained : "When walls are more than usually damp, rain is expected." The Zuñi Indians in New Mexico say that "when the locks of the Navajos grow damp in the scalp-house, surely it will rain." From this we may assume that scalps are slightly hygroscopic, probably from the salt which they contain. Also, owing to excessive moisture, clouds appear soft and lowering, and reflect the glare of iron-works and the lights of large towns.

With the gloomy, close, and muggy weather, some people are troubled with rheumatic pains and neuralgia, old wounds and corns are painful, animals and birds are restless, and drains and ditches give out an offensive smell.

A glance at the diagram will show that the barometer falls during the whole of the front of the cyclone. Therefore the explanation of the universally known fact that the barometer generally falls for bad weather is, that both rain and wind are usually associated with the front of a cyclone. When we discuss secondaries, we shall find a kind of rain for which the barometer does not fall; and in our chapter on forecasting for solitary observers we shall explain why it sometimes rains while the barometer is rising, and why there is sometimes fine weather while the mercury is falling.

Now, to take prognostics which belong to different portions of the cyclone-front. By reference to Fig. 2 it will be seen that in the outskirts of the cyclone-front there is a narrow ring of halo-forming sky. Hence the sayings: "Halos predict a storm (rain and wind, or snow and wind) at no great distance, and the open side of the halo tells the quarter from which it may be expected." "Mock suns predict a more remote and less certain change of weather."

Inside the halo sky comes the denser cloud which gives the pale watery sun and moon. Still nearer the center we find rain, first in the form of drizzle, then as driving rain. In the left front we find ill-defined showers and a dirty sky.

We have now come to the trough of the cyclone. The line of the trough is often associated with a squall or heavy shower, commonly known as "a clearing shower." This is much more marked in the portion of the trough which lies to the south of the cyclone's center than on the northern side.

Then we enter the rear of the cyclone. The whole of the rear is characterized by a cool, dry air, with a brisk, exhilarating feel, and a bright sky, with hard cumulus cloud. These features are the exact converse of those we found in the cyclone-front. In the cloud-forms especially we see this difference. All over the front, whether high up or low down, whether as delicate cirrus or heavy gloom, the clouds are of a stratified type. Even under the rain, when we get a peep through a break in the clouds, we find them lying like a more or less thick sheet over the earth. All over the rear, on the contrary, clouds take the rocky form known as cumulus; cirrus is almost unknown in the rear of a cyclone-center in the temperate zone.

In the exhilarating quality of the air we find the meaning of the proverb, "Do business with men when the wind is in the northwest." A northwest wind belongs to the rear of a cyclone, and improves men's tempers, as opposed to the neuralgic and rheumatic sensations in front of a cyclone, which make them cross.

As to the details of the different portions of the rear. Immediately behind the center small patches of blue sky appear. Farther from the center we find showers or cold squalls; beyond them, hard detached cumulus or strato-cumulus ; still farther the sky is blue again. In the south of the cyclone, near the outskirts, the long, wispy clouds known as windy cirrus and "mares' tails" are observed. These indicate wind rather than rain, as they are outside of the rainy portion of the cyclone.

THE ANTECHAMBER OF CONSCIOUSNESS.

By FRANCIS SPEIR, Jr.

I.

THACKERAY, in that delightful "Roundabout Paper," "De Finibus," confidentially discusses with the reader the genesis of his literary creations. In introducing the subject of this article I shall quote this passage as presenting a pleasing exposition of a certain phase of literary work that is accomplished apparently without any action of the will to account for the result : "I have been surprised at the observations made by some of my characters. It seems as if an occult power was moving the pen. The personage does or says something, and I ask, 'How the dickens did he come to think of that?' Every man has observed in dreams the vast dramatic power that is evinced—I won't say the surprising power, for nothing does surprise you in dreams—but those strange characters you meet make instant observations, of which you never can have thought previously. In like manner the imagination foretells things ; we spake anon of the afflated style, when a writer is like a pythoness on her oracle tripod, and mighty words—words which he can not help—come blowing, and whistling, and moaning through the speaking-tubes of his bodily organ." Our literature is full of suggestions such as this, pointing to an intellectual workhouse where all is unknown, but from which comes forth polished, finished work, done how or where we know not.

My attention for some years has been directed to the subject of unconscious cerebration, as it is called, and to the literature of the subject, from the suggestion of its existence by Leibnitz, to its present exposition by Carpenter, Holmes, and Miss Cobbe. It was with a desire to throw the light of further-collected facts upon the relation of a conscious activity to a possible unconscious cerebral activity that I undertook the task of collecting the necessary data. The method employed in collecting these data was the well-known one of the distribution of printed questions to be answered from personal experience. While much of the ground has been gone over before, the questions at issue have been tested largely upon hearsay evidence—tales that somebody has told of somebody else ; hence, with our human infirmities, the generalization founded on such facts can fairly be questioned.

From a distribution of over six hundred copies of a set of questions upon this subject, I have received one hundred and two answers, largely from professional men and women, and from the students of the upper classes of our leading American colleges, each paper subscribed with the name, age, and address of the sender. In obtaining this mass of material, I have been placed under great obligations to President McCosh; to Professor George P. Fisher, of Yale College; Professor William James, of Harvard College; President Robinson, of Brown; Professor Osborn, of Princeton; Professor Stanley Hall, of Johns Hopkins; Dr. Nicholas Murray Butler, of Columbia; and Professor Torrey, of the University of Vermont. The healthy, normal side of this subject is the only one I shall attempt to consider, leaving the questions of morbid pathology to those who alone can weigh the evidence it throws upon the subject.

If, in our experience, we witness an effect, we know, by the inexorable logic of science, that its existence must be due to some efficient cause. "Verily a tree is known by its fruit" is sound teaching and sound sense—it is axiomatic. If a solution of a mathematical problem can really be revealed to us in consciousness, while we are busied about other things, it must inevitably have been performed by means of the processes which regularly lead to such a result, even if we are not conscious at the time of employing such processes. It could not have come spontaneously, but only as the result. As a consequence, in such a case we would be bound to predicate some exercise of intellectual powers, actively working during unconsciousness. The circular before referred to comprised eleven questions; those, the results of which are specially used here, are as follow:

SECOND QUESTION.—"1. When you are unable to recall the name of something wanted, and you say, 'Never mind, it will occur to me,' are you conscious of any effort at searching after it?

"2. When you are, do you feel some trouble or weight in your effort?

"3. When you are not, does the idea ever, when it occurs, seem to have come back spontaneously, without being suggested by any perceived association of ideas?"

THIRD QUESTION.—"During sleep, have you ever pursued a logical, connected train of thought upon some topic or problem in which you have reached some conclusion, and the steps and conclusions of which you have remembered on awakening?"

SIXTH QUESTION.—"1. Can you wake precisely at a given hour, determined upon before going to sleep, without waking up many times before the appointed time?

"2. If you can, then (*a*) is this habitual, or do you often fail? (*b*) Are you conscious, before waking, of any feeling? (describe it), or (*c*) do you come directly from oblivion into consciousness?"

NINTH QUESTION.—"When perplexed at your progress in any work (mathematical, professional, literary, chess, puzzles, etc.), have you ever left it unfinished and turned your attention to other things, and, after some time, on voluntarily returning to it, have found yourself able at once to satisfactorily master it?"

TENTH QUESTION.—"1. Have you ever been conscious of having involuntarily discovered something new—e. g., an invention, a literary or poetical creation, a mathematical solution, etc.?

"2. If yes, then has this flashed into consciousness in the form of a clear conception?"

II.

In order to set forth logically the results of the answers received, I shall group them according to the following analysis: Does there exist in man the power to exert intellectual activity during unconsciousness in these several forms?

First. When the effort is simple by reproducing past experiences in obedience to a mandate of will.

Second. By comparing related facts and arriving at a settled judgment.

Third. When the effort is more complex by continuing old trains of thought begun in consciousness and proceeding logically, step by step, to a rational settled conclusion.

Fourth. When the effort is most complex, by commencing and continuing new trains of thought without having voluntarily undertaken or continued them, and arriving at results of original creation as inventions, literary and musical creations, etc.

First. The first division of the subject is restricted to the antechamber of consciousness; it contains the inquiry as to the possibility of working for a lost idea, fact or fancy, while consciously devoting one's whole attention to something else. This established, it must follow that during the unconscious interval which intervenes between the desire for the lost object and its occurrence in consciousness, an intellectual activity was at work similar in all respects to the conscious activity, minus the element of self-looking, at self-working. Some of the instances given in the answers, worthy of being cited as illustrations, are as follow:

1. Miss H——, of Princeton, writes: "Yesterday I tried at breakfast to recollect the name of Azimolate Khan, but could only remember that it began with 'Az.' I felt vexed for a moment only, and totally forgot it, being absorbed in an interesting subject. In about ten minutes I said aloud, 'It is Azimolate Khan!' and was scarcely conscious that I had said it, it came so suddenly to me."

2. Mr. V——, of Brooklyn, New York city, writes: "While writing a paper on a medical subject I had occasion to use the technical term for a swoon, which I could not recall. At this point, being obliged to attend a lecture, spontaneously and apparently without reason—for the two subjects had no connection—the word 'syncope' shot across my mind; immediately after, the medical paper came into my mind."

3. Mr. L——, of New York, writes: "One case I remember. I was trying to think of the name of a book and gave it up. About half an hour after I was talking of something else, when all of a sudden I

blurted out the name without any conscious volition on my part, or without thinking anything about the book at all."

4. The writer, being asked who was the author of the pamphlet entitled "Taxation no Tyranny," although knowing well, was unable to answer. Two days afterward, while working at a law brief, suddenly said aloud, "Dr. Johnson wrote 'Taxation no Tyranny.'" He took pains to examine the writing before him and the chain of reasoning engaged in at the time, but could not find the slightest suggestion of the answer. He had apparently forgotten entirely about the question asked him for at least forty-eight hours prior to answering it, and had experienced no trouble or weight of mind in the interval.

5. Mr. B——, of New York city, writes: "Only recently, being asked a lady's name, I found myself only able to recall the surname. I said, 'I will think of the other—wait a moment.' Walking along the street a few minutes later, I heard one small boy say to another, 'You lie like ——!' Instantly, I was conscious that something in that phrase bore upon something else that I had been thinking about, but what it was I could not tell. An hour or so later, when occupied in writing, it flashed upon me that the name of the lady that I was searching for was 'Lila,' and instantaneously the relevancy of the phrase overheard in the street came to me; it was the resemblance in sound, 'Lila,' to 'lie like.'"

Under this head the statistical result may be summed up thus: Ninety-five persons answered this particular inquiry. Of these, ninety-one per cent state that they have had similar experiences, three per cent have not. With forty per cent there was often an oppressive feeling of trouble or anxiety experienced just before the solution had come, and not then attributable to anything in particular; but after the answer had come, twenty per cent almost instinctively attributed this oppression to the fatigue of mental effort involved in finding the answer. With sixty per cent no oppression was noted; about thirty per cent noticed that the answers frequently came after comparative rest or sleep, and seventy per cent have not noticed the time of the recovery. Almost every individual says concerning these experiences, "They are of such frequent occurrence that when they happen I pay no special attention to them."

Second. If, while unconscious, it is possible to attain the result that can only come from reckoning—a judgment founded on the comparative relations of a unit—this must be the result of an intellectual activity which exists unknown to the conscious self, and entirely escapes all notice from the moderately keen eye of self-consciousness. Most people can approximately tell what hour of the day it is without consulting a timepiece, and, the less they are in the habit of depending upon such a luxury, the more accurate their computation is likely to be. This computation is founded on a calculation of the comparative value of the time between two known points translated into the arbitrary measure of hours and minutes. A calculation is performed, however quickly or unconsciously. The question of being able to wake from a sound sleep at an unusual time, in obedience to an act of will registered before going to sleep, brings this phenomenon with this subdivision. The answers to the question in this connection are as follow:

1. Mr. L——, of Philadelphia, writes: "I can wake within a few minutes of a given time without effort. Habitually I wake within a few minutes of a fixed time. I can, however, wake without effort at a different time."

2. Miss B——, of New York city: "Yes, at an early or unusual hour, by repeating the time to myself once or twice before going to sleep. I seldom wake before the hour determined upon, and never fail to wake then. I come directly into full consciousness at all times."

3. Mr. A——, of Omaha, Nebraska: "Yes, within three minutes."

4. Mrs. Y——, of Paterson, New Jersey: "Can awaken at a given hour determined upon without waking before at all. Have not found it necessary to do so often, but have never failed in the attempt. Come directly from oblivion into consciousness."

5. Mr. C——, of Orange, New Jersey: "Have never overslept when my mind has been charged before retiring."

6. Mr. B——, of Paterson, New Jersey: "I was intrusted by the attending physician with the administering of medicines to my wife, who was very dangerously ill. It was of the greatest importance that a certain medicine should be given every two hours as exactly as possible, day and night. I am an extraordinarily sound sleeper; but, for six weeks, I woke up every two hours methodically, and never missed giving the medicines once during that time. I always came directly from oblivion into consciousness. During the first few nights I was as exact and methodical as in the last."

The statistical result is as follows: Forty per cent claim to have this power in a strongly marked degree; they can wake up at an unusual hour without having their rest at all disturbed prior to their awaking. Of this forty per cent, about fifty per cent say that they are conscious of being troubled just before the real light of consciousness has risen; the other fifty per cent say that they only know that at the predetermined time they are awake. The sixty per cent who do not possess this power in a marked degree are about evenly divided, one half spending their night continually disturbed by false alarms, and the other fifty per cent sleep peacefully on with rest unbroken, either at, before, or after the appointed hour for awaking. I find that I overlooked one important point in this inquiry, namely, whether those who can wake up at almost the minute of the given hour possess a similarly accurate power of measuring time in consciousness.

To sum up the conclusions on this point: Many people during a state of perfect unconsciousness can accurately measure time as well as and often better than they can in consciousness, when they largely rely upon an artificial time-computer. In doing this they may perform an intellectual process similar in all respects to the conscious act of calculating a distance between known points.

Third. This division covers a wide field of intellectual activity, and the inquiry is here directed to the result of systematically connected thought, omitting only original research which is considered later. Is there unconscious reasoning of a complex kind employed when old work begun in consciousness is carried on or brought to a logical conclusion unknown to the thinker, as in the cases of solving mathematical problems and the like? Let the facts speak for themselves:

1. Mr. T——, of Metuchen, New Jersey, writes: "I had earnestly been trying to make a trial-balance, and had at last left off working—the summary of the Dr. and Cr. sides of the account showing a difference of £2 10*s.* 0*d.*, the Dr. side being so much smaller. The error I had not found on Saturday night when I left the counting-house. On this same Saturday night I retired, feeling nervous and angry with myself. Some time in the night I dreamed thus: I was seated at my desk in the counting-house and in a good light; everything was orderly and natural, the ledger lying open before me. I was looking over the balances of the accounts and comparing them with the sums in the trial balance-sheet. Soon I came to a small account having a debit balance of £2 10*s.* 0*d.* I looked at it, called myself sundry uncomplimentary names, spoke to myself in a deprecating manner of my own eyes, and at last put the £2 10*s.* 0*d.* to its proper side of the trial balance-sheet, shut up and went home. Here the dream abruptly ended. I arose at the usual Sunday time, dressed carefully, breakfasted, went to call upon some young lady friends, and to go to church, especially with one of them. Suddenly, the dream flashed on my memory. I went for the keys, opened the office, also the safe: got the ledger, turned to the folio my dream indicated. There was the account whose balance was the sum wanted, and which I had omitted to put in the balance-sheet where it was now put, and my year's posting proved correct."

2. Mrs. R——, of Wakefield, Rhode Island, writes: "When perplexed by work, often leave it and find the thing easy after a little while. Once, while working at a chess-puzzle for several evenings, I went to bed, fell asleep, and worked it correctly; sprang out of bed, found it correct, and wrote it down for fear of forgetting it; found it right in the morning. I had worked at the puzzle so long that it was perfectly familiar, and, before going to sleep, lay thinking of new moves; the right one was merely a continuation of my waking thoughts."

3. Mr. S——, of New York city, writes: "I remember but one instance, in which case, when about nineteen years of age, I correctly solved a mathematical problem, during a sound sleep, so far as I could judge, which had puzzled me before going to bed."

4. Mr. F——, of Brooklyn, New York, writes: "I was studying algebra, in which I was quite interested, and had an example to do in six unknown quantities. I worked at it in the evening, and after an hour or two gave it up and went to bed. That night I dreamed the way to do it was so-and-so, and arrived at the right answer. On awakening in the morning I tried it before I got up, and, following the way suggested in the dream, got the correct answer."

5. Mrs. B——, of New York city, writes: "In guessing double acrostics, of which I am very fond, I often carry a question on in my mind without giving it any particular attention, until at last the answer suddenly occurs to me."

6. Mr. F——, of Westerly, Rhode Island, writes: "Have worked out many algebraic or geometrical problems during sleep. Have, when some years ago in Worcester Academy, scanned some fifty or seventy-five lines of Virgil, not yet translated, except ten or fifteen, felt tired, went to bed, in sleep accurately translated all of it, and remembered it on waking."

7. Mrs. B——, of New York city, writes: "In reading a difficult language, I read the text over without attempting to translate, getting as much of the sense as this perusal may give; then I leave it for a few hours and return to it later, to find its difficulties solved—this is not the case when the second follows directly on the first."

8. Dr. S——, of New York city, writes: "I remember, when in college, having been engaged all the evening in working on a geometrical problem and going to bed with it unsolved; having an uneasy sleep, in which I dreamed of geometrical figures and of working with them; and, on awaking in the night, the solution of the problem suggested itself to my mind, which solution I remembered and found correct next day."

9. Mrs. X——, of Paterson, New Jersey, writes: "Have played a game of whist in my sleep and deplored the mistakes I have made while awake; gone over the whole game, replayed it in sleep, with much better results and to my entire satisfaction."

The following cases belong to the same class, and demonstrate that perception in consciousness often occurs long after the perception of the fact has been fully grasped by the individual unconsciously. The discussion of the relations of consciousness to unconsciousness will appear later:

10. Mr. B—— (a Frenchman) writes as follows: "I once received a French letter from Paris, describing a race, and ending with the English words, "O how I am sorry!" I could not decipher the words when awake, but it came to me in sleep as it was written, and I made it out perfectly then."

11. Mrs. D—— writes as follows: "On one occasion, having written a note, I received a note which conveyed to my mind the idea that the writer had entirely misunderstood my communication. I fell asleep

while composing a reply which should set the matter straight, and awoke with an instantaneous certainty that an erroneous punctuation had obscured the writer's meaning, which in reality coincided with my intention and required no answer. Evidently, the mental accuracy was greater when asleep than when awake—very humiliating."

12. Mrs. P——, of Omaha, writes: "I have many times heard remarks, the significance of which I did not fully comprehend at the time, and weeks afterward have had them flash suddenly into my mind with all their import."

The statistical result is as follows: About eighty-five per cent of those answering claim to have arrived at definite results of work begun in consciousness and left unfinished—at results of a finished logical nature—at results that could come only by bridging the gap between the beginning and partial continuation in consciousness, and the perfected conclusion by predicating the existence and operation of unconscious intellectual effort as the necessary cause of the known result. Fifteen per cent state that they have no experience concerning the phenomena inquired about. Of those answering affirmatively, nearly fifty per cent give examples to corroborate their assertions.

Fourth. The fourth division is of intellectual activity producing new ideas, creations, and inventions, when there has been no conscious beginning. Does such work proceed in unconsciousness? Some of the facts brought to light by the circular are as follow:

1. Miss P——, of New York city: "While reading the 'Evening Post' I happened to observe an anagram offered for solution. The anagram was, 'Got a scant religion.' I read the paragraph aloud to a friend sitting near me, and then turned to something else, a novel in which I was interested, and which quite absorbed me, and gave the anagram no further thought. I never consciously thought of the anagram until the following morning, when, as I was walking and trying to recall a dream, the word 'Congregationalist' flashed through my mind. The word had no connection with my dream, and came to me so suddenly and involuntarily on my part, that I was obliged to think for a moment before I could connect it with anything, and then it occurred to me that it was the solution of the anagram which I had read the evening before."

2. Mr. P——, of Omaha: "I had to perform endless multiplications at school as a task, and suddenly became conscious of a law governing the process which enabled me to attain the result almost instantaneously; discovery flashed into consciousness as a clear conception."

3. Mrs. H——, of Bergen Point, New Jersey: "Have often awakened with a part of an essay all ready, with a letter wholly prepared once or twice, with a few stanzas composed on subjects that I had endeavored to treat in rhyme; once or twice also on subjects that I had not attempted or thought to write upon in verse; example, 'The Edu-

cated Alligator,' which you have. These, on waking, have come into memory without effort."

4. Mr. S——, of New York city: "In my senior year at college I had an essay to write that troubled me unusually. After trying to decide upon the subject until quite late, I fell asleep and dreamed not only of the subject, but of the analysis and of all the details. The next morning I wrote out just what I had dreamed, and found it far more satisfactory than anything I had ever done in the same line before."

5. Mrs. H——, of New York city: "Yes, many times. A carol (the author is unknown), which has been sung in many of our New York churches, came into my mind, words and music simultaneously, after I had been reading till long past midnight. There was nothing in the book to suggest the carol, and I was walking toward the door for the purpose of retiring, when the words and music came to me as involuntarily and distinctly as if it had been something to which I was an unexpected listener. So with similar productions—I often write as if from dictation—quite unprepared for what is coming," etc.

6. Mrs. ——, of New York city: "I have written a good deal of verse of various kinds—sometimes this has flashed into my mind as a clear conception, but more frequently slower. In one case, I wrote a long piece, of a rather satiric character, in easy rhythm, as fast as I could set down the words, and it needed little or no revision—usually I am dissatisfied with my first copies."

7. Mrs. ——, of New York city: "In half sleep, after consciousness is gone, I am frequently startled wide awake by the recollection of some forgotten duty—or by some entirely new idea, usually something that is practical in character, and works well when put into shape. Measured by my normal standard, these ideas are usually above the medium in clearness and precision, completeness and practical value. They are new thoughts, but rather expedients, business suggestions; for instance, the idea of writing a series of articles for 'Scribner's Monthly' on microscopic studies of vegetable and animal life in its completeness came to me in this way—articles which appeared and have since appeared in book-form, and laid the foundation of most of my work since."

8. Mr. S——, of Philadelphia: "While walking alone, busily engaged in trying to settle a business question—so intent as to have my head down, and quite oblivious to anything around me—an original conundrum presented itself to my mind. (I confess to a slight weakness for punning, but rather despise conundrums, and this is the first and only one I ever concocted.) The conundrum was as much an interruption of my course of thought as if another person had come to me—it was, 'Why is so much bread baked? Because it is all (k)needed.'"

The results of the answers in this subdivision may be summed up as follows: Only thirty per cent claim to have suddenly discovered the results of creative effort, which they would venture to call new, in the line of practical inventions, poetry, literary conceptions, mathematical solutions, and the like; these creations appeared suddenly, most often while the individuals were engaged on matters foreign to the discovery. About forty per cent do not answer the question, and thirty per cent answer in the negative, while, of those answering affirmatively, only about twenty-five per cent are able to give examples.

III.

To clearly apprehend the significance of the facts thus set forth, it is necessary to understand thoroughly the conception of human consciousness. The chief difficulty which obscures this subject is a lack of proper differentiation between self-consciousness and consciousness, in their several relations to human unconsciousness. Self-consciousness is the intellectual perception by which the *ego* recognizes the *ego* as seeing, thinking, judging, feeling, etc. Consciousness, though often confounded with self-consciousness, is not a synonym for it, but is merely the environment in which self-consciousness is manifested. Human consciousness is not an intellectual property or state of the mind—it is purely a state of nervous activity; it is nervous energy in a most intensified form. Human unconsciousness is a less intensive state of nervous activity, wherein self-consciousness can not be manifested.

Nervous activity is ever the same in kind, and, while there is a great difference between the simplest reflex action and the highly developed state of consciousness, yet this is one of degree alone. Intellectual activity is ever present in the brain, and every moment is producing new results without cessation from birth to the grave. As a condition precedent to the existence of these results of our changing thought-life, the brain requires a supply of blood commensurate to the calls made upon the nervous energy and corresponding to the intensity of its activity.

There is a broad belt of border-land between consciousness and unconsciousness, whose limits are uncertain, yet where the manifestations of intellectual activity are recognized, which prove the kinship of the life of those two great regions. The world judges each individual by his intellectual activity manifested in consciousness. Upon this our judgment of him is based, as this can be the only known or possible method of determination. Many "mute inglorious Miltons" undoubtedly exist, yet for the world they do not really exist. Shakespeare produced the character of Hamlet, Hamlet came through the door of Shakespeare's consciousness to greet and astonish the world, yet Hamlet and Lear and all the glorious company of Shakespeare's known creations represent not a tenth part of the finished idealized conceptions of character that were born in Shakespeare's brain while he, unconscious of his labor, acted or wrote or dreamed after an evening of sack at the "Mermaid" with "rare Ben Jonson."

That indefinable personal equation which distinguishes the individual from all others is the limit and condition of his unconscious intellectual activity. Newton discovered the workings of the law of gravitation and happily perceived it in his phase of consciousness, and the world has become so much the wiser on account of this accident. The workings of other laws of Nature he undoubtedly formulated to just as definite and logical conclusions, yet these he and the world have never known. It is most improbable that Sir Isaac Newton in consciousness or unconsciousness ever created a finished ideal like Becky Sharp or the Heathen Chinee. The novelist Dumas, after a period of active living and omnivorous reading, would board his yacht on the Mediterranean, and lie half torpid and dreaming day after day on her deck, hardly noticing his environment; then suddenly would change from this state and betake himself to work, summoning into existence the results of his unconscious intellectual activity, dashing off chapter after chapter, not of some work on theology, but of a novel. So perhaps were Chicot and the immortal Athos, Porthos, and Aramis conceived. The limitations of the personal equation forbid the idea of an intellectual activity existing in unconsciousness unlike that found in consciousness. On the contrary, we are forced to predicate an absolute relation in kind between the results of such activity in the two distinct phases of our life; just as when we see the fossil types characterizing a Silurian stratum cropping out horizontally on some hillside, we can as surely determine what will distinguish the fossil forms of the interior of that hill as if we summoned an army to remove the incubus and lay bare for our scrutiny the stratum at the center.

Having once possessed knowledge, we can never lose it; the power to use it may be temporarily lost, but there is no knowing when the proper chord may not be struck, and the old fact of memory or the old problem long worked out may not be regained. All our experiences may fade away into the realm of unconsciousness, yet they are not lost, they are only dormant and biding their time. In consciousness we find the means by which we can exercise self-consciousness, and thus know our own existence. In this most specialized form of purely nervous activity, the *ego* is discerned as an *ego* endowed with reason, will, and conscience. What the genesis of consciousness from unconsciousness is, we know not; there is as great a gap here as the step from nothing to life, and there we must stop, seeing our limitations with reverent agnosticism and recognizing the folly and futility of further investigations. The materialization of consciousness has been ordered by science and it must be recognized as a fact. Mind and body unquestionably react, but the psychologists have, in the past, mingled too great an amount of matter with mind, and science is now surely, but certainly and with pitiless accuracy, separating the two, pointing out the clay that was mixed with the metal supposed to be pure, and relegating the baser substance to its proper place. The fact that consciousness is a mere phase of nervous activity, pertaining to the body and consequently of the earth, earthy, has nothing to do with the mortality or the immortality of the *ego*; it is an argument neither for nor against the existence of a soul. A dog possesses clearly defined consciousness, and yet it is not necessary to predicate a soul as the accompaniment of this possession; to argue thus is to degrade the meaning of the word soul. Consciousness is but a part of normal flesh-and-blood existence; it is nourished and stimulated by a generous supply of healthy blood, and becomes changed and unhealthy by disease. It seems probable that in the vast land of unconsciousness, intellectual activity becomes manifold, and each of the many sides of our nature, untrammeled by the restraints of conscious volition, carries on a ceaseless activity, the results of which we sometimes receive and recognize in consciousness.

OUR ICE-SUPPLY AND ITS DANGERS.

By T. MITCHELL PRUDDEN, M. D.

IT is not easy to realize that the region which we now call New York was once a mass of bare, tangled rock, bound fast beneath vast glacial ice-fields, which, stretching away to the north and west, held all northern North America in the bonds of a dreary desolation.

The gigantic fissure through which welled up from the earth's center that vast mass of molten rock which we call the Palisades, had closed fast upon its sides long before the last reign of ice began; and when at length the cold era was established, and the great glaciers, with their slow, resistless flow, came sweeping down, year after year, over the top of the Palisades, across the rocks on which New York stands, and at last broke off and melted in the sea, the ice-mass, and the fragments of stone which it had torn loose in its progress and held fast along its sides and bottom, planed down the rocks over which it passed, and left upon their exposed surfaces broad grooves, shallow channels, and innumerable scratches, which to-day tell silently the story of that ancient reign of ice. The house-building *furor* is fast removing these ancient records, but in the upper parts of the island and on the top of the Palisades one still may see large numbers of glacier grooves and scratches.

How long this ancient Ice age lasted it would be useless to conjecture now; but at length the climate changed, and by little and little the ice relaxed its grasp. The stones and bowlders, with which it was so relentlessly grinding off the surface of the earth's crust hereabout, dropped from its fingers and lay much as we may see them now in some parts of the track of the North American ice-belt, scattered or piled in masses where the ancient moraines were gathered, miles from their kindred rock. And now over the surface of the bare, forbidding region, slowly as the ages passed, crept the verdure which, out of rock and air, was to recreate the world. Probably long before man made his appearance, on this part of the continent at least, the ice had all melted and gone to waste. He came, however, at last, the savage, the Dutchman, and—most perfect bloom—the New-Yorker.

In the early days of New York village life the stolid citizen was far too busy to spend much thought on luxuries, in adapting himself to the untried conditions of the New World and maintaining his foothold against the wiles of his savage neighbors. His gustatory sense had, with characteristic directness, been contented for the most part with plain unadorned rum when it felt the need of extraneous stimulation, and this and other simple drinks were either taken *au naturel* or re-enforced by the addition of spices under the kindly offices of fire. Water, which the early citizen may, in moments of relaxation of the mental fiber, have playfully regarded as a beverage, was largely derived from wells, and thus might be had of sufficient coolness to be palatable under natural conditions.

Half a century ago twoscore wagons sufficed to distribute all the ice which was used in New York; but the demand steadily increased, until now nearly three and a half million tons are harvested annually, in favorable seasons, in the vicinity of New York. Few realize how much the comfort and welfare of all classes, especially in the summer months, have come to depend upon that free use of ice which its abundance and cheapness make possible. Untold dangers from the consumption of spoiled meat and other fresh foods are warded off through its preservative action, and their market value largely reduced. And who can adequately realize the comfort and even life-saving agency of ice among the sick and injured? When the charities of New York are summed up, the free distribution of ice-water in some districts of our city should not be reckoned as among the least important.

Perhaps of any single class of consumers of ice the brewers use the largest quantities, to control the high temperature which accompanies the fermentation of the wort; but for this purpose processes of artificial cooling have, to a considerable extent, replaced the natural ice. Ice-cream makers and market-men are also among the most important consumers. The experiences of the writer would hardly justify him in enlarging upon the multifarious concoctions into which ice enters before they are handed by the white-aproned autocrats over the more or less attractive bars of our no longer temperate town to gilded and brazen youth and statesmen, or to their humbler *confrères* and constituents more commonly only dirt-adorned. On the whole, in spite of its not infrequent abuse when used for drinking purposes in large quantities and at unsuitable times, ice is one of the most indispensable of the accessories to modern life, especially in large towns; and it is wholly to our credit that its free use has become a really noteworthy national trait.

New York has its ice-speculators and its Ice Exchange, and the Ice Exchange has its bulls and bears, who watch the thermometer and the weather as intently as their *confrères* in another market watch railroad-construction and the ticker. An ice-trade journal, published in Philadelphia, does valiant duty in endeavoring to establish the position of the ice-trade among the great industries of the world.

From twenty to twenty-five million tons of ice are annually harvested in the United States, and not far from fifty million dollars are invested in the business. It is probable that we use more ice annually in the city of New York alone than is consumed on the whole Continent of Europe. It is said that, if all the ice-houses on the Hudson River below Albany were placed side by side, the line would be not far from seven miles long! If we estimate the bulk of the entire amount of ice annually harvested in the vicinity of New York each year, we find that, if piled in a solid mass one hundred feet square, it would make a column soaring nearly three miles into the air. We have thus a veritable return of the Ice age—on quite a small scale, it is true, in comparison with that which Nature brought about by tilting up the strata and lowering the temperature of North America a few degrees; but then man always cuts a rather sorry figure when his "tinkerings" with the elements are brought into contrast with the results of Nature's wholesale and forceful work. A certain amount of ice is brought to New York from Maine each year, but the quantity is not large except after open winters, when the crop hereabout has been a poor one. Norwegian ice, with which England is largely supplied, has been at times brought here in small quantities, but under ordinary conditions it can not compete in the market with the domestic product.

Rockland, Highland, and Greenwood Lakes; Swartout Pond, near Rockland Lake; an artificial pond called Lake Meheagh, on Verplank's Point; Tuckahoe Pond, on the Bronx River; Van Cortland Pond, in the new Van Cortland Park; Ice or Hinkley's Pond, on one of the small tributaries of the Croton River; and Lake Mahopac—all furnish varying amounts of ice for our market. But the Hudson River between Poughkeepsie and Albany forms the principal source of our supply. In the earlier days of ice-harvesting on a large scale upon the Hudson there was a good deal of quarreling among the representatives of the various companies as to their rights to particularly favorable ice-fields, and lively skirmishes over evanescent and uncertain boundary-lines took place between the employés of rival companies, with the natural sequelæ of broken heads and noses. But with legally acquired rights to the water-front on or near which the storage-houses are built, and the occupation year after year of particular tracts upon the ice, these picturesque struggles, which recalled in little the frequent encounters between the retainers of rival houses in feudal times, have passed away, and the scene of personal encounters is mostly transferred to bar-rooms. But the modern representative (God save the mark!) of feudal times now and again stirs up discord in the form of strikes and their retroactive accompaniments among the ice-harvesters.

The days when the most approved manner of storing ice was to dig a hole in the ground, fill it with ice, pack straw around it, and cover it tightly, leaving some primitive mode of access, have long since passed, and some of the larger storage-houses are not only moderately tasteful in their construction and ornamentation, but are fairly imposing in size. The better houses, mostly of wood, have efficient drainage at the bottom. The walls are hollow, containing an air-chamber, and within this a chamber filled with some non-conducting material, such as sawdust or hay, while above is a loft with abundant ventilation. The larger houses are divided into a number of rooms, so that when they are opened for the removal of the ice the whole mass need not be exposed to the warm air which enters.

The cakes of ice, which in this region are cut of a uniform size of about twenty-two by thirty-two inches, are usually laid flat, a solid stratum at the bottom. Above this they are placed on top of one another with two or three inches of space between their edges, the joints being broken every few tiers, as in masonry, by allowing the cakes to lap over the joints below. The object of the space between the edges of the cakes is to prevent their freezing together, for if this occurred their removal would entail a good deal of additional labor in breaking them apart, and a large loss of ice which would be chipped off in the operation. When the houses are about full, a solid layer of cakes is laid on top, so that the air may not circulate between them, and the whole is covered by hay. A varying number of smaller buildings are usually clustered about the storage-houses, such as engine-house, tool-house, shop, barn, and often the boarding-house for the men.

But let us leave these dry details and get out of doors, lest Winter should steal a march on us, and we should lose those first delicate crystal spiculæ shooting out from shore and rock with which he commonly begins his work alike on lake and stream and pool. Who does not know those fragile ice-fringes, losing themselves in the open water, which the first frosty nights in autumn leave behind often only to fade away in the next day's sun? But when at length, after these early, playful exhibitions of his gathering power, Winter really bends himself to his work, the crystals grow longer and thicker, their sides join, and finally the completed film formed along the surface shuts in the water, and his dominion is complete. Now his tactics change. The caprices which he has displayed as the long crystals stole out in ever-varying directions from the shore are subdued, and the stern work of strengthening his fetters fairly begins. After the first film of ice is formed, the freezing goes on directly downward as the heat from the water radiates off into the colder air above. The direction of crystallization has changed, and is now at right angles to that in which it began. Unhindered radiation of heat from the water out into the air is the secret of the continued formation of ice. If anything occurs to prevent this, the ice stops forming beneath. A fall of snow upon the already-made ice greatly retards its continued formation.

Some of the elder ice-harvesters still foster a feeble flame upon the broken altars of the old star-worshipers in their belief that the cold rays from the winter moon and stars favor in some mysterious way the growth of their ice, since this forms best on the clearest nights. Who would dispel this chaste illusion by suggesting that the clouds which draw themselves at times over the faces of their gentle deities delay the fruition of their hopes simply by preventing the escape of the earth's heat off into space? In the vicinity of New York, where open winters are so common and changes of temperature are so great and frequent, the formation of the ice is a matter of the greatest solicitude to the ice-farmer, upon whose vigilance and judgment may largely depend both the value and abundance of his winter's crop.

Let us suppose that Winter is fairly in possession along the river. The storage-houses, machinery, and tools for harvesting the ice are in order. Many of the horses which have dragged the last year's crop in its daily distribution about the town have been brought up on the returning empty barges to recruit a little before their winter's work begins. The men who are to engage in the harvesting are beginning to straggle in to make their arrangements. A certain number of these are regular employés of the companies who work in town during the summer. Then along the Hudson many of the workers are farmers from the adjacent country, who, not over-busy in the winter, come down singly or in squads, looking upon their term of service to the ice companies as a sort of lark with a pecuniary bias. Then there is a large number of rovers, living, Heaven only knows how, through the rest of the year, who straggle along the river, work long enough to keep themselves drunk for a day or a week, and then brace up for another turn on the same or on a different field.

While all these forces are gathering toward the ice-harvesting centers, the superintendent is keeping a sharp lookout on the formation of the ice. The field has to be staked out as early as possible in order to secure it against invasion by competitors. It used to be necessary to make a fence four feet high around a pre-empted ice-field in order to legally secure it, but stakes or twigs stuck in the ice four feet apart are deemed sufficient now.

While the weather is clear and cold, and the colder and clearer the better, all goes well with the growing crop as slowly the water yields itself into its crystal bonds, and the domain of the clear, solid ice creeps downward inch by inch. But this condition of affairs, quite ideal from the standpoint of the ice-farmer, is apt in this region to be evanescent. If the grip of the cold relaxes by day, the formation of ice may stop, and even a film of that already made may melt away in the water beneath; but at night again another layer may be added, and so, with many halts, retreats, and slow advances, little by little the ice-mass thickens. But who would imagine that, written in the ice, as plainly as the sequence of geologic ages is written in the rocks, is the record of these alternate victories of heat and cold as they contended for the mastery of the water during the winter days and nights? Strange as it may seem, the record is there, however, and, stranger yet, is written in air. Look at the edge of a cake of ice which has formed in comparatively still water during such alternations of temperature as are common in our winters, and you will be very apt to see a series of bands of transparent ice, between which lie layers of tiny air-bubbles. In still water, when the ice for any reason stops forming for a time, bubbles of air from the water or from the bottom are apt to rise and collect beneath the ice, and when the freezing again begins they are entangled and held fast between the old and the new ice-layers, a permanent record of the relaxation of the thrall of the cold long enough for their collection. In running water such bubbles are apt to be swept away, and the ice remains transparent.

While the ice is thus forming the ice-farmer looks on, his spirits rising in inverse ratio to the height of the thermometer. To the vagaries of the temperature he must reconcile himself as best he may. But let his *bête noire*, the snow—if so violent an antithesis be permissible—appear, and he will be on the alert at once. The snow-flakes, delicately adjusting themselves to one another as they settle down upon the ice, build up among their crystals myriads of tiny air-cavities, and the whole forms a veritable blanket which hinders radiation. It is warm for the same reason that a down comfortable is—it prevents the escape of heat. Now, what shall our ice-farmer do? It does little good to swear at the snow, although he usually has recourse to this procedure first. If the already formed ice is thick enough to bear the teams, he may scrape the snow off, and then the freezing can go on. But if not, he sends his men over the field to cut small holes here and there through it; the water wells up, flows over the top, forming a layer of slush, a good deal of the air is expelled, and the whole freezes, forming a whitish layer which is called *snow-ice*. This layer is whitish because of the air-bubbles which it still retains, but it conducts off the heat fairly well, and his crop goes on forming. This operation is called "tapping" or "bleeding" the ice. Ice which has a very thick snow layer is called "fat ice." This snow-ice is not as valuable as clear ice, for householders object to it because they fancy that it is not so pure, and the assurances of the dealers that the impurity is only air appear to have little weight. So the more responsible dealers usually find it for their interest to remove most of the snow layer. A little snow-ice on the cakes, however, makes them keep better. We shall see by and by that there are really very good reasons why the snow-ice from certain sources should not be used for drinking purposes.

At last the vicissitudes and anxieties of the growth of the ice-crop are over, and the "boss" decides that the cutting shall begin. A good deal of responsibility attaches to this decision, and many factors must be considered. If a good thick mass has formed, say from ten to fourteen inches, the sooner it is under cover the better. But if the weather has been fickle and warm, and the layer is only from four to six inches thick, it is a more difficult matter to decide. It is better to have six-inch ice in the houses than none at all; but if by a little delay two or three more inches could be secured, it would be an immense gain. But, on the other hand, while waiting for the added increment, warm weather or a freshet may suddenly come on, and the whole crop be lost. Repeated snows upon the ice are bad; an untimely breaking up of the ice by a freshet is worse. But if, during the freshet, the whole field is swept away, there is often still a chance for a new crop to form. About the worst combination of misfortunes—and it is not so very infrequent—is for the ice to soften, to be all jumbled up and mixed with dirt and *débris* of various kinds from above by a freshet, and then, before this mongrel and well-nigh useless mass can be swept down stream and away, to have the whole thing freeze solid on the spot.

The first step in the ice-gathering is to draw two long, straight lines on the ice at right angles to each other. With these as a guide, a part of the field is marked off into blocks of the proper size, and it then looks like a gigantic checker-board. Then other teams come on, drawing the ice-plows, which are long, narrow-toothed blades, running along the ice like great horizontal saws. One plow follows another along these narrow grooves until they are deep enough, so that long strips of the outlined cakes may be readily loosened by a saw. These separated strips of ice grooved off into cakes are pushed along in a channel which has been cleared through the ice up to the foot of the endless chain that runs up an incline to the houses. Here the strips are broken apart along the deep cross-grooves into cakes by hand-bars shaped like great chisels. The cakes are now caught upon projections from the elevating chain, moved by steam, and up they go one after another to the platforms at varying heights around the ice-houses, or directly in at the main door. When the cakes enter the storage-rooms they are shoved along wooden runs or movable tracks to various parts of the chamber where layer by layer they are stowed away. Sometimes a single inclined plane with its endless chain leads up to a series of platforms along the front of the building, which tier above tier slope gently away from the top of the incline, so that the ice-cakes, leaving the chain at the center, are slid down the platforms to the various openings. The ice-mass, which is quite imposing as one looks across it in the larger houses, must be carefully and skillfully packed, and be self-supporting. Many a dealer has come to grief by the fall of his building from the collapse of the ice-mass within. The construction of the great and elaborate ice palaces with which the people of Montreal and St. Paul sometimes amuse themselves in winter is comparatively simple, because water is poured in between the blocks, and the whole freezes to a solid mass as it rises. But the art of the commercial ice-builder consists in making his ice-mass solid enough to stand alone with just as little freezing together of the cakes as possible.

The more responsible harvesters are particular about the appearance of the ice which is stored, and if a block is dirty from inclosed sand, grass, weeds, etc., it has to be thrown away. That sounds very simple, to throw away a cake of ice. But if one fancies that, in doing it, the offending object is dragged bodily off by hand out of the way, he underrates the value of machinery, gravity, and American enterprise. No, the offending block is floated on toward the elevator along with the rest, and goes up in line like any reputable sheep. But its Nemesis awaits it at the top in the person of a man with a spiked stick, with which he unceremoniously bounces it off the end of the platform into a heap of broken ice below by one quick, skillful thrust.

Too much ice must not be grooved out by the plows in advance, lest in case of rain the channels should fill and freeze solid and the labor be wasted. So it is frequently necessary for the workers at the plow to be out long before light in the morning, grooving out blocks for the harvesters when the day begins. It is a picturesque sight, these hardy men, muffled to their ears, following the gingerly-treading teams back and forth over the ice-fields by the light of flaring, smoky torches hung on poles stuck in the ice. More than once the swinging lamps which have done patriotic duty in some campaign torch-light procession have found themselves relegated to the austere and chilling duty of illuminating hoary ice-fields before the dawn, instead of lending force to the political claims and convictions of would-be or would-continue-to-be American statesmen after dark.

Serious accidents are not frequent upon the ice-fields, but occasionally a horse breaks through or slips off into the icy water, and has to be hauled out with ropes. The men, too, frequently enough, get an unexpected bath amid the jeers of their fellows. A change of clothing and a stiff horn of whisky are the not unwillingly endured penalties which such an awkwardness entails.

At Highland Lake, which lies in the hollow of a natural rocky terrace a short distance back from and above the Hudson below West Point, no power other than that of gravity is used in carrying the ice to the houses some distance away. A wooden runway leads from the edge of the lake down the hill. Down this the ice-cakes glide one after another as they are fed in directly from the water-level above.

When the cakes approach the storage-houses they enter the top of a great wooden tower, in which the runways form a huge spiral. Down this they slide with diminished velocity, and may be switched off at any desired level directly into the houses.

In good seasons a considerable quantity of ice is usually "stacked"; that is, piled up in great heaps outside of the houses and covered up with hay or straw. This ice is shipped early in the season, and the housed stock saved for later use. Sometimes a considerable quantity of ice is carried over from one year to another, and serves as an insurance against bad seasons. When winter is coming on and navigation liable to close on the river, all the available boats and barges are filled with ice and sent down stream, and from this stock the early winter deliveries are made. When this is exhausted, the supply may be drawn from the houses which are in communication with the city by rail, or the ice may be cut near these houses, put into the cars, and forwarded directly.

The insurance of ice-houses against fire, and in many regions against wind, is an important matter. For, singularly enough, the destruction of these buildings by fire is of such frequent occurrence that the insurance rates are quite high. They seem to be favorite playthings of the lightning, and it is probable that the shelter which the lee and sunny sides of these large and often isolated structures afford to that most disgusting combination of man, brute, and devil, the modern tramp, would account for a considerable number of ice-house fires.

The ice used in New York is largely brought to town in barges or canal-boats, though a considerable quantity, notably that called Croton Lake ice, from Ice Pond and Tuckahoe, comes in by rail. The ice-barge, so familiar an object upon the river, is a singular, awkward craft, with a great square house upon the deck, with slender derricks in line fore and aft, and a small windmill at one end for pumping out the water as it accumulates from the melting of the ice. The New York ice-dealers are greatly favored by the extensive water-front of the city, which enables them to almost entirely dispense with expensive storehouses in town, the ice being for the most part loaded from the barges directly into the delivery-wagons.

The delivery of ice in New York is largely controlled by the companies which harvest it, by whom drivers are employed to supply their customers. There are other concerns which make contracts for ice on the large scale from the harvesters, and sell and deliver to their own customers. But there is still a large number of men called "bushwhackers" and "guerrillas," who work up custom in various sections of the town, and get their ice where they can from the regular dealers.

We are all familiar with the appearance of the ice-wagon, heavy and usually clumsily built, a slight tilt of the body forward, painted with any of the colors of the rainbow, or more commonly with colors which the rainbow would blush to acknowledge, and adorned with some more or less attractive name. The name on the ice-wagon, often apparently indicating the source of the ice, may or may not actually do so. A large part of our ice comes from the Hudson River, and, as a rule, whenever and wherever Hudson River ice is more conveniently and cheaply delivered than that from any other source, this is what the consumer gets, no matter what the flaring legend of the cart may seem to imply.

Except the grocer, who visits us in guises as varied as are the wares which he dispenses, the ice-man is that one of the outside ministrants to our wants with whose appearance we are most familiar. Few escape hearing the infernal clatter of the ash and garbage carts, which, under the new *régime*, leave a trail of murdered sleep behind them in the early morning, or the uncanny whoop and screech of the milk-dispenser. But they do not form such constant features of the street-life as do the ice-carts and their officers after the world gets fairly astir. We have all watched with interest the skill with which the experienced ice-man cracks off his larger and smaller rectangular blocks, and the ingenuity which he exhibits, when it is not carried in-doors, in selecting a sunny place for its deposition on the steps. The never-failing attraction of the ice-cart for peripatetic children is the occasion of many picturesque street scenes, and not infrequently of serious accidents, for every now and then an ice-block falls off behind, and woe to the youngster who happens to be in its way, for ice weighs about fifty-eight pounds to the cubic foot.

There is yet another phase in the story of the ice which we must not overlook. We have been wont to believe that the fragment of ice which forms such a constant and pleasing adjunct to our glass of water is the very ideal of purity. But the common belief that, in freezing, water purifies itself from all kinds of contamination, has been shown to be quite untrue ; and, ungraceful as is the task of dispelling so pleasing an illusion, we shall do unwisely if we ignore the revelations of modern science, and for the sake of a momentary mental quietude remain oblivious to a real danger which the indiscriminate use of ice for drinking purposes unquestionably entails.

Nearly all natural water contains considerable numbers of tiny vegetable organisms called bacteria. So small are they, for the most part, that thousands upon thousands of them, if ranged side by side, would scarcely reach across the head of a pin. Most of them are not only, so far as we know, entirely harmless when taken into the system in moderate quantities, but they are among the most important factors contributing to the cleanliness and continued salubrity of our surroundings. Wherever under ordinary conditions a bit of organic matter, animal or vegetable, dies, these tiny structures appear and tear it to pieces, atom by atom, using a very small proportion as food, and furnishing the remainder in suitable innocuous form for the nutrition of animals and other plants in turn. There seems to be at first something repellent in the thought that we are liable to unwittingly consume, in our drinking-water, as we do in much of our uncooked food, such numbers of living things. But this feeling is largely due to the wholly unjustifiable disposition which many persons display to class them among "bugs" and "worms." Nobody thinks of considering the consumption of fresh fruits and vegetables as anything uncanny. And yet all the vegetables and fruits which we commonly use as foods are really made up of vast aggregates of tiny living organisms called cells, each one of which is the analogue of the single organisms called bacteria, and under ordinary conditions one is just as little harmful as the other. The leaves and fruits of some plants are exceedingly poisonous, and yet he who should on that account decline to eat lettuce or peaches would be justly reckoned among Nature's weaklings. The air we breathe in inhabited regions always contains considerable numbers of bacteria, but they are for the most part harmless.

We have learned a great deal about these, our invisible friends the bacteria, within the past few years; and as that knowledge has grown, we have found out that lurking among them are a few species, not friends but our most inveterate foes, producing disease and even death. The fact is that, under ordinary favorable sanitary conditions, the bacteria which we are liable to breathe or consume are as harmless as so much air. But if we insist upon drinking dirty water or breathing filthy air, we increase, as we deserve to do, our risk of coming under the influence of the baneful forms.

There are a few diseases common among us, the most important of which are consumption and typhoid fever, which are caused by the presence and action in the body of certain well-defined and well-known species of bacteria. These diseases never occur except under the influence of these particular forms of germs. And the reason why consumption and typhoid fever continually occur is because certain of us get some of these bacteria in the living condition into our bodies, where they grow and induce the disease. All persons are not alike susceptible to the action of these bacteria, naturally or at all times, so that they doubtless not infrequently gain access to our bodies without producing ill effects. Now every intelligent person knows, or ought to know, that water polluted with sewage is not a proper thing to drink; and, while there may be other causes which render it unwholesome, the cause which we know most about is the presence of certain forms of disease-producing bacteria. This knowledge it is which has led to the construction for large towns of expensive systems of water-supply, whose reservoirs are situated at considerable distances, where, presumably, no sewage contamination is possible. If we can be certain that the water from our city supplies can not contain sewage or human or animal excretions of any kind, we are pretty safe, so far as our present knowledge goes, in giving ourselves little concern about the number of bacteria which it may contain.

But let us return to our ice. He who is familiar with the researches of Tyndall and other physicists on the structure of ice, knows how little we can be aware, from the simple inspection of a lump of clear ice, beautiful as it is, how marvelously it is built up crystal by crystal into the solid form we know so well. But if we turn a beam of sunlight upon it, concentrated by a lens, the exquisite and varied steltate figures which flash out within the solid mass as the magic touch of the sunbeam releases the molecules of water from their crystal bonds, give us enchanting glimpses of the still but half-won secrets of beauty and of order with which Nature so fondly sports and still so cleverly conceals.

But the resources of the physicist do not suffice to conjure all its secrets from a block of ice. It is left for the student of that phase of Nature which we call life to discover that this very type of cold impassive lifelessness may be fairly teeming, absolutely transparent though it be, with whole families and races of living things—dormant from chill it is true, but ready at the touch of warmth, and in the presence of their food, to start on a career of growth and multiplication to which the increase in the world's populousness since the old Ice age faded is but a poor and halting comparison.

We can not follow the student of these lowly forms of life, which have become entangled among the ice-crystals, as he calls them back from their torpor, separates them one by one, and patiently studies their life-history. It is not enough to melt the ice and look at the resulting water through the microscope. But he mingles the melted ice with a transparent compound of gelatin and beef-tea, and puts the whole in a warm place, and after a few hours or days, wherever in this semi-solid gelatin a living germ from the ice had lain, a tiny speck or rounded mass appears—a "colony" he calls it—which is made up of thousands of the descendants of the old rescued and thawed bacterial ancestor. And so the biologist can separate the species one from another, cultivate them in various receptacles, and learn whether they belong among man's friends or foes.

A great deal of careful experiment has shown * that water in freezing largely expels its coarser visible contaminations, and also that a large proportion of the invisible bacteria which it contains may be destroyed, even as many as ninety per cent. But still large numbers may remain alive, for many species are quite invulnerable to the action of cold. It has been found that in ice formed from water containing many bacteria, such as water with sewage contamination, the snow-ice almost invariably contains many more living bacteria than the more solid, transparent part; so that the snow layer should be especially avoided in ice obtained from questionable sources.

Unfortunately, the bacteria which cause typhoid fever are not readily killed by cold, and may remain alive for months, fast frozen in

* See the New York "Medical Record," March 26 and April 2, 1887.

a block of ice. But the typhoid-fever germ can be present in water, so far as we know, only when it is contaminated with refuse from persons suffering from the disease; so that, if we can be certain that our ice was cut from water uncontaminated with sewage or human waste, we have nothing to fear from its use so far as this disease is concerned. All of the pond and lake ice supplied to New York is of fairly good, and most of it of excellent quality; and no doubt the danger of contracting typhoid fever from the use of the larger part of the Hudson River ice is quite remote. But a considerable quantity of the Hudson River ice is cut just below Albany, where the stream is so greatly contaminated with the sewage of two large towns, Troy and Albany, as to be absolutely filthy. In both of these towns typhoid fever is of frequent occurrence during the period in which ice is forming, and the waste from the victims passes directly into the river. There would, therefore, seem to be a very real danger in the use of *some* of the Hudson River ice.

The responses which one commonly meets when he has occasion to point out the possibility of danger from the use of impure ice are apt to be, "How horrid! Why do you add another misery to life?" or "Our fathers have never suffered from the use of ice, and why should we?" etc. No sanitary danger has ever been pointed out, and no improvement instituted, which had not to stem just such opposition. The cesspool has given way to the sewer, and the well to the distant water-supply, in the face of the same sort of silly protest on the part of many of those whose own most vital interests were at stake—persons who ignore the fact that an ever-increasing vigilance is necessary to ward off the dangers which the aggregation of large numbers of people in cities invariably entails. The danger from the use of impure ice in New York, though wide-spread, is not very alarming, so far as the liability to extensive outbreaks of typhoid fever are concerned, because most of the ice which is furnished appears to be of fair quality. But if the risk of an attack of the disease can be warded off from one in ten thousand of our fellows, the gain is worth the effort. We do not need to be unduly squeamish, but it is well enough to be intelligent in the face of sanitary dangers. The ice companies, unless controlled by the State Health Department, will doubtless continue to cut and to furnish sewage ice along with the rest just as long as their customers will tolerate it. But if householders would insist upon the assurance that their ice should not come from the immediate vicinity of Albany, or from directly below other towns draining into the river, the companies would soon recognize that acquiescence in this reasonable demand is the wiser and more profitable course.

We are a long-suffering people here in New York, and, if our common manifestations of patience were commendable instead of contemptible, we should be deserving of monumental record. We are, it is true, saved in a measure from swill-milk, bob-veal, and numerous other abominations, by the vigilance of our health-officers. But we smilingly swallow the dirt which the horse-car companies order thrown upon our streets to save themselves the expense of roughening the roadway in a legitimate manner; we allow the elevated railroads to rain dust and cinders down into our eyes, and drop oil and water upon our heads and shoulders; we stumble over boxes and baskets stored upon our sidewalks; we permit political tricksters to juggle with our lives, even with Asiatic cholera staring us in the face; we breathe, in some of our most popular, expensive, and fashionable theatres, air which, from lack of adequate ventilation, rivals that of crowded tenements and the steerage of stuffy steamships; and in innumerable other ways are the victims of the money-making and money-saving instincts of our fellows. But, after all, the complacency with which we swallow the frozen filth which some of the ice companies at times deliver at our doors—albeit often very clear and harmless in appearance—because it is cheaper for them to harvest it where the sewers empty than elsewhere, affords a spectacle of self-abasement as melancholy as it is disgusting. If the householder be not brave enough to encounter the scorn of the ice-dealer, or is too tender-hearted to witness the picture of injured innocence which he often presents when the details of his business are called in question, the ice which is used for drinking purposes may be put in a separate receptacle, so as not to come directly in contact with the water.

Our space does not permit us to consider the growing importance of the manufacture of artificial ice. But it seems probable that the sanitary problems which the use of natural ice for drinking purposes presents, especially in large cities, may find their solution in the increasing employment of artificial ice made from distilled or otherwise purified water.

And now, at last, as we look at the old Ice age and the new together, we find that, while in some respects alike, they differ widely in their significance and in their relationship to man. The mysteries of the old ice-crystals perished with them; the grandeur of the great glaciers passed unseen, leaving desolation. What hardy germs were caught up by the ice as the last cold period came on, and were swept from one part of the continent to another, we can only conjecture.

The new Ice era came in response to the intelligence and the growing refinement of the material needs of man. Petty as it is in its physical proportions, when set in fancy beside the old, it overtops it in significance, because it owes its very existence to the comfort and healing which we compel it to bear. Our blocks of ice can to-day be made to yield up their secrets of marvelous physical constitution, and we can read out of their inmost recesses the dainty records of the elemental warfare which silently went on, as now heat and now cold was victor in the water where it slowly formed. We can nurse back to life the delicate organisms which were sporting in the water when it fell under the spell of Winter's wand, and wring from them one by one the secret of their relationship to man—framing the pass-words by which we are to know whether they belong among his friends or foes.

The use of ice should, and doubtless will, become more and more universal and liberal as time goes on, and we may unreservedly hail as a triumph of enterprise and skill, and a cherished factor in the advancement of man's weal, the advent and growth of our New Age of Ice.

FLAMINGOES AT HOME.

By HENRY A. BLAKE.

I DO not know if much has been written on the subject of the breeding of flamingoes, or if their habits have been closely examined; but I have a distinct recollection of a print in a book on natural history read by me many years ago, where the flamingo is depicted straddling on a very high nest, with the legs hanging down on either side. I have always thought this to be rather a peculiar way of sitting during incubation, and, finding that the birds bred in large numbers in the islands of Inagua, Andros, and Abaco, I determined to satisfy myself by personal observation as to the manner in which these birds sit on their eggs while hatching.

The flamingoes are very shy, and are only found in the remote and rarely-visited lagoons. When seen in flocks of some hundreds standing in long lines, they look at a distance like battalions of British troops on parade, their brilliant pink plumage showing up well against the dark-green mangroves with which the lagoons are generally fringed.

In May they begin to repair the old nests, or to raise new ones, which is done by scooping up the surrounding mud with the beak, while they stand on the nest and pat it into shape and proper consistency with the foot. It is no mere treading on the mud, but one foot is used at a time, and the sounding slaps with which the cones of mud are got into shape can be heard at a considerable distance.

The nests are always grouped close together, sometimes as many as four hundred being found in a "rookery." They stand from three to four feet apart, the area occupied by each nest being about twelve square feet. The birds do not always return to the same breeding-place, and if disturbed much while breeding, or if the very young birds are taken from the nest, they will probably breed next year in some other rookery, many of which are to be found in the least accessible parts of the great stretches of swamps.

Having settled upon their breeding-ground for the year, the old nests are at once taken possession of by the oldest or strongest birds, who proceed to repair them by adding to the top the inch or more washed off by the rains since last tenanted. If the nest is very low, four or five inches may be added, and sticks, shells, or anything else that may be lying about the base, are scooped up and worked in without any apparent arrangement, just as if the soft mud with the *débris* contained in it were lifted with a trowel and placed on the top. There is no preparation made for the new repair of the old nest, and, if an addled egg remains, it is simply covered over with the fresh stuff and built into the cone. I measured some scores of nests. The highest was fifteen inches, the lowest eight inches, the latter being the height of the nests in the first year. The nests were about eighteen inches in diameter at the bottom, and nine to eleven inches on the top. The concavity was very slight. In a few cases about half a dozen feathers were found on the nest, but in general the eggs were laid on the bare mud. I said "eggs," but, out of some hundreds of nests examined by me in June, there were not half a dozen which contained two eggs, one being the usual number. As some of those taken at the time were in an advanced stage of incubation, it is probable that at each breeding-season but one egg is usually laid.

THE FLAMINGO.

The nesting-season is from the middle to the end of May. The young birds are hatched about the end of June or beginning of July, and about the first week in August are so fully fledged that, while some can fly, almost all are capable of taking care of themselves. It is at this time that the young birds are taken, sometimes by scores. As the nests are in places so difficult of access, and the birds could not be carried without danger of breaking their slender legs, the problem of getting them to the shore for shipment would be difficult to solve, were it not that a flock of young birds are easily driven. When they are first approached, those who can fly get up and circle overhead, but in a very short time they pitch with the other young birds now being driven away, and they do not fly again. The entire lot are then driven like a flock of sheep over the flat banks of marl or through the shallow lagoons. In the molting-season the old birds are sometimes thus driven, as they can not then fly.

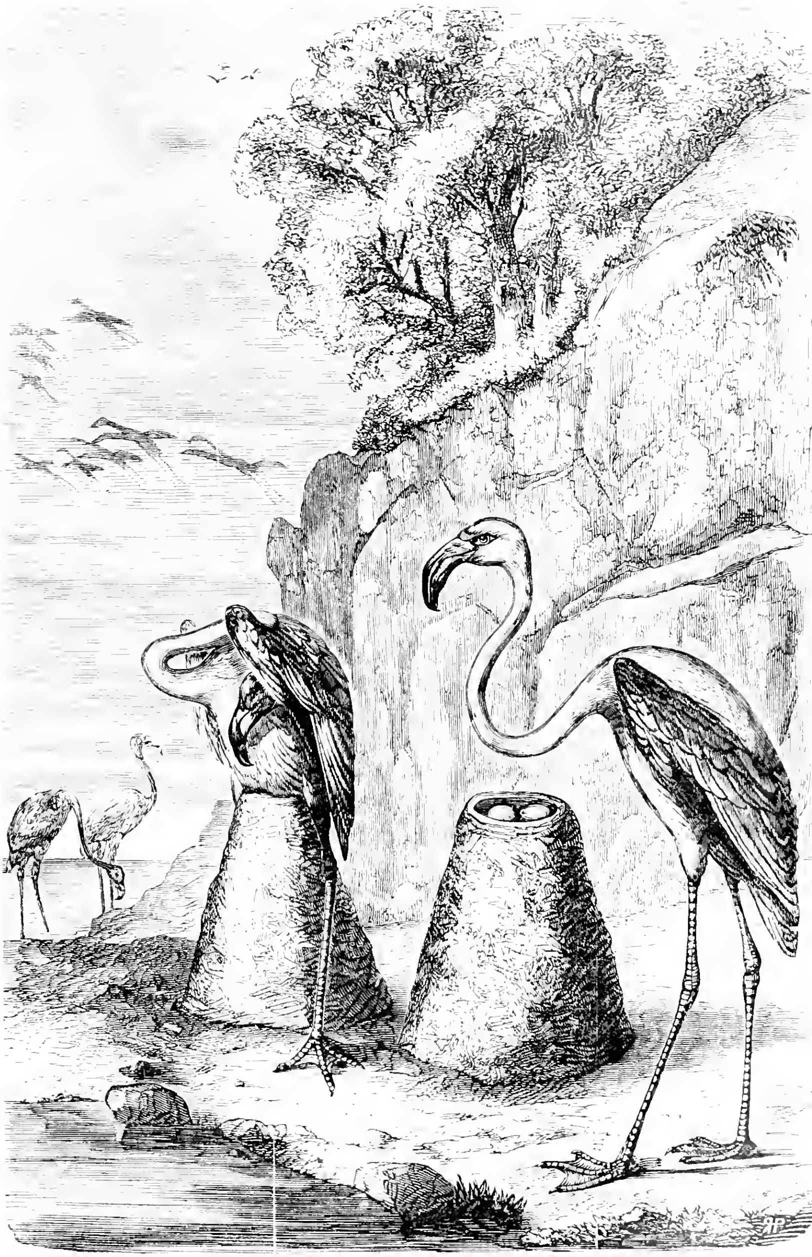
I left Nassau on the 3d of June, and, having called at several places on the way, dropped anchor at Bustick Point on the evening of Monday, the 6th of June. Bustick Point is on the island of Abaco, the eastern side of which is fringed with a line of bays forming an almost uninterrupted belt of land, with a few deep passages through which ships can enter. On two of these bays are built the settlements of Hope Town and Green Turtle Bay, the principal towns of Abaco. Between the bays and the shore of the island the beautifully clear water of the Bahamas is always smooth, and the sailing is delightful, the changing views of island and bays affording constant interest.

We had arranged with two guides to meet us, and at 5 A. M. on the 7th of June we landed. I was accompanied by Lord George Fitz-Gerald, and Lieutenant Robertson, Second West India Regiment. The air was still, but the morning was fresh and bright, and the walk across the island was most enjoyable. The ground was picturesquely rugged, and the path led up and down and around low hills planted with pineapples, of which great heaps of the full but green fruit were piled upon the shore ready for shipment, while the golden hue of the fruit with which the trees were still crowned showed that much of the crop was already too ripe to bear the voyage to a foreign market. All the care of cultivation could not keep down the creepers of all kinds that covered every available stump; white and purple passion-flowers and wild grape-vine fringed the path. Convolvuli of various hues opened their bell-shaped flowers to the morning sun, while the broad, green leaves of the bananas planted here and there were jeweled along the edges with sparkling dew-drops.

Beyond the pine-field we entered a thick wood, completely carpeted with maiden-hair and other ferns, while almost every tree was laden with orchids. Over the crest of the hill the scene changed. The wood ended and the path plunged downward through bracken so thick and so high that the morning-glory climbed the stem to thrust its bright, blue bells into the fresh morning air. One expected to see the deer start from its lair, and nothing was wanting, save the melody from the woods, to fancy one's self in an English park on a summer morning.

Beneath us the broad, lake-like lagoon stretched away to the dim distance. Not a ripple ruffled its surface, and on its calm breast, as in a mirror, were reflected two rocky islets, whose precipitous sides were crowned with a tropical wealth of vegetation, while over them wheeled in graceful circles a pair of "johnny-crows" found in the Bahamas on the islands of Abaco, Andros, and Bahama only. Away on the horizon to the west were low clumps of mangroves showing where the flat banks of marl begin among the lagoons of which the flamingoes build.

Fastened among the great mangrove-trees that here fringe the



Nest of the Flamingo (according to the old belief).

lake we found a boat belonging to William Albury, one of our guides, and pulled away for the western shore. The lake, or lagoon, is here about five feet deep, the bottom soft, and covered with slimy weed. Albury, who is a keen old sportsman, informed us that the wild pigeon breeds about the lake, and in the season he shoots large numbers of them. If, however, they fall into the water, there is an end of them, as the lagoon is infested by numbers of small sharks, which not only snap up the birds, but are particularly bold—so much so that to swim for the pigeons would probably result in a serious bite, if not worse. I confess that I received this information with a certain amount of reserve, my experience being that sharks are very cowardly in these waters, so that even large ones rarely attack men. However, about two hours later, when we had pulled to the other side, where the waters were so shallow that all hands were obliged to wade, and drag the boat over the sharp rocks, covered with small univalve shell-fish, on which the flamingoes feed, I had ocular demonstration of their boldness. We had observed the ripple caused by a shoal of bonefish, when suddenly a small shark by which they were being chased turned and came straight for the bare, black legs of Edgar Archer, our second guide. He flung an oar at it, which missed it, but caused it to sheer off. The fish was only about two and a half feet long, but the determination to try the flavor of Archer's legs was unmistakable.

Hauling the boat high and dry, we started for the nests. By this time the sun was very strong, and, as the soft marl banks, sparsely clothed with dwarf mangrove and button-wood, afforded no shade, the walking was decidedly hot. The banks are penetrated in every direction with the arms of the lagoon, now almost dry, but after southwesterly winds they fill so that a boat will float in them. The nests are always built in these lagoons or on their brink, so that when the water rises the nests are almost awash. Indeed, in rough weather the eggs are sometimes washed out of them. The birds can thus feed while sitting.

A walk of about an hour brought us to a small clump of trees, from behind which we carefully reconnoitred, and there, within half a mile, we saw the birds. Very lovely the pink mass looked in the bright sunlight. There were three separate clusters of nests, every one of which was occupied, while the male birds stood around, their heads raised high, as they evidently suspected mischief. As I could not clearly make out with my glasses the position of the legs of the sitting birds, there was nothing for it but a long stalk over the intervening slob, and with the blazing sun now almost vertical. The first quarter of a mile was comparatively easy, as we could creep on our hands and knees; but then we came to a point where nothing but vermicular motion could avail us, and for real hard work let me recommend it to those who are content with very active exercise without attaining a high rate of progression. The tropical sun beat down upon us, hatless as we now were, from a cloudless sky; but I suppose that our profuse perspiration saved us from any ill effects, the rapid evaporation counteracting the sun's heat. It may be that I was too anxious about reaching a favorable point of observation to think of it, but I can not say that I even suffered any inconvenience.

At length, having crawled under the roots of the dwarf mangroves that covered the slob like a network of croquet-hoops, we found ourselves at the edge of the marl, and within one hundred and fifty yards of the birds, who were still undisturbed. Here, with my glasses, I could see every feather, note the color of the eyes, and watch every movement. There were, we calculated, between seven hundred and a thousand birds, and a continuous low, goose-like cackling was kept up. Never did I see a more beautiful mass of color. The male birds had now all got together, standing about five feet high, and with necks extended and heads erect were evidently watching events, preserving in the mean time a masterly inactivity. Now and again one would stretch out his great black and scarlet wings, but the general effect was the most exquisite shade of pink, as the feathers of the breast and back are much lighter than those of the wings.

The hens sat on the nests, and some were sitting down in the muddy lagoon. I watched them carefully for nearly an hour, and looked at every nest to see if the legs were extended along the side. In no case did I see a leg. I saw the birds go on to the nest and sit down. I saw them get up, and step down from the nest. In every instance the legs were folded under the bird in the usual manner. In my opinion my observation settles the point as to the mode of sitting; for even if, as I had been assured, the birds sit both ways, it is improbable that among the hundreds then sitting not one would have extended the legs. Remembering the great length of the flamingo's legs, it is evident that on a new nest, not more than eight inches high, the hen could not thus sit, nor would even the highest nest allow of the legs being extended while the bird sat upon it.

After having watched the birds for the time named, we showed ourselves; but whether they had observed us before, and become somewhat accustomed to our presence, or that when sitting they are more easy to approach than I thought, the only effect was that the hens left the nest, and, joining the male birds, prepared for eventualities, nor did they take wing until we had begun to walk up to the rookery. While we were examining it, the birds flew round us within forty yards, so that we could have shot them easily. Of course, we did not do so. To prevent the destruction of flamingoes and pigeons by their wholesale slaughter during the breeding-season, the Bahamas Legislature passed in 1885 a Wild Birds' Protection Act, from which I hope for good results.

Having taken a few eggs as specimens, and lifted carefully on to a board a nest destined for presentation to the Zoölogical Society, which was carried safely to the ship on the head of Edgar Archer, but unfortunately broken afterward by a clumsy sailor, we started for the yacht. On our way back across the lagoon we pulled to a high clump of mangroves, in which the frigate-birds build every year. There were some scores of them sitting among the branches, but no nests had yet been built; nor could we discover in the clefts of the small rocky island near the landing-place the nest of the "johnny-crow," which breeds there every year.

In due course we wended our way back through the sturdy bracken and the silent woods. The morning-glory had already changed its blue coat for one of deep purple, and the leaves looked thirsting for their nightly draught of dew. We quenched our thirst with the warm juice of the pineapples cut fresh from the trees, and a plunge overboard into the clear cool water soon removed every trace of fatigue. —*Nineteenth Century.*

CURIOUS FACTS OF INHERITANCE.

THE strength of the law which determines the transmission of character—physical or otherwise—from parents to children is still far from receiving due attention and recognition. A striking instance of inheritance is often hailed as wonderful and inexplicable; yet such cases are merely exaggerated examples of a phenomenon of which every family, nay, every individual, affords proof. We all inherit, in a more or less variable degree, the physical constitution and the mental aptitudes of our parents; but this law of inheritance is liable to so much modification, that frequently its operation becomes entirely lost to view. When two forces act upon a body, the resultant is a mean between the two components. This mean is not merely in all cases different from either component, but it is a variable mean, the variation depending upon the relative strength of the two component forces. Inheritance affords an exact parallel to this elementary law of mechanics. No child is entirely like either parent; and the inheritance of two sets of tendencies which may be allied, opposed, or indifferent to each other, may result in characters possessed by neither parent. This result is no breach of the law of inheritance, but is in strict harmony with its most precise conditions; yet it is not surprising that a law subject to such indefinite variation should gain scanty recognition except from those who have made it a special study, and can, therefore, readily distinguish an explicable exception to a law from an actual breach of it.

That the law of inheritance should be constant in its operation, however variable in its effects, is not a matter for surprise. That like produces like is the law written upon the universal face of Nature. Sir Henry Holland truly observes that the real subject for surprise is not that any peculiarity should be inherited, but that any should fail to be inherited; and Darwin remarks that the most correct way of viewing the whole subject would be to look at the inheritance of every character as the rule, and non-inheritance as the anomaly.

It is obvious that instances of inheritance are most likely to be noticed and recorded when the inherited peculiarity is striking and abnormal. Countless instances of inheritance come under our notice almost every day; but the vast majority of them are too slight and insignificant to attract attention. A slight peculiarity of feature, complexion, or voice will readily pass unnoticed; but if a striking deformity be inherited, or some disease pursue a family through several generations, it can hardly escape the most careless observation. Cases are on record of families whose members were characterized by the possession of a supernumerary digit on the hands and feet, and this remarkable peculiarity has been transmitted through five generations, showing how strong is the force of inheritance even in such a minor detail of structure. A still more singular instance is that of Lambert, the well-known "porcupine-man," whose skin was thickly covered with warty projections, which were periodically molted. He had six children, who were similarly affected; and two of his grandsons inherited the strange peculiarity. The writer is acquainted with a gentleman who has a marked drooping of the left eyelid. His son inherits this peculiarity, but in a less remarkable degree. One of the most singular instances of inheritance is that recorded by Decandolle. There was a family in France of which the leading representative could, when a youth, pitch several books from his head by the movement of the scalp alone, and he used to win wagers by performing this feat. His father, uncle, grandfather, and his three children possessed the same power to the same unusual degree. This family became divided eight generations ago into two branches, so that the head of the above-mentioned branch is cousin in the seventh degree to the head of the other branch. This distant cousin resided in another part of France, and on being asked whether he possessed the same faculty, immediately exhibited his power.

Haller, the celebrated physiologist, records that the family of the Bentivoglio all possessed a tumor which used to swell when a damp wind blew, and this strange peculiarity was transmitted from father to son. The frequency among the Romans of surnames indicating some physical peculiarity—Naso, Labeo, Bucco, Capito—would seem to show that the fact of certain types of feature being transmitted through several generations had already been remarked. This fact lies almost unnoticed under many current forms of expression. We speak of a certain type of face being aristocratic or the reverse, by which we mean that physical features characterizing certain classes are transmitted so surely as to become the recognized appanage of those classes. The aristocracy of Western Europe pride themselves upon possessing and transmitting small hands, the outward and visible sign of long exemption from manual labor. The aristocracy of China pride themselves on the smallness of their feet. The implication is in each case the same. We often speak of "blue blood" without any clear idea of the meaning of the expression. The phrase probably arose from the recognition of the fact, that the aristocratic and luxurious classes, who are exempt from actual labor, possess a fine white skin, through which the veins show themselves clearly, and that this peculiarity is transmitted from generation to generation. It is a fact of history that Frederick William I of Prussia succeeded in producing a stock of gigantic grenadiers by matching his tallest soldiers with women of similar proportions.

No point of structure is too minute to afford instances of the law of inheritance. A little spot on the iris has been transmitted from parent to child. The possession of a few abnormally long hairs in the eyebrows has been known to characterize the various members of certain families; and the characteristic of a patch of prematurely gray hair has been transmitted through several generations. Many curious records exist of families which possessed and gloried in their scars, moles, and other family marks, faithfully transmitted from parent to child—a sort of secret hall-mark stamped by Nature to attest the genuineness of the line. Peculiarities in the structure, arrangement, and even in the chemical composition of the teeth, frequently run in families. The writer, among whose professional duties the frequent inspection of tongues holds a humble but not unimportant place, has remarked a notable peculiarity in the shape of that organ transmitted from mother to daughter.

Peculiarities in the expression of the face are frequently inherited. Many cases may be remarked where an inherited resemblance is quite latent when the features are in repose, but comes out with startling vividness when they are agitated by emotion. Among the acquaintances of the writer is a gentleman who, when smiling, exhibits a most peculiar and unusual arrangement of lines at the outer angle of the eyes, and this characteristic has been faithfully transmitted to his children.

When we turn to the lower animals, the instances of striking peculiarities being inherited are still more numerous, and have been recorded with greater care and accuracy. Every breeder and trainer is aware of the vast importance of the law of inheritance, and no instance is allowed to escape notice; but it is only in recent years that philosophers have become alive to the fact that in his physical nature man obeys the ordinary biological laws which prevail among the higher animals, and that among these laws the law of inheritance holds the first place. A breed of cattle once existed which possessed only one horn, and this was transmitted. A one-antlered stag has been known to propagate this peculiarity in his offspring. A rabbit produced a litter in which one of the young was one-eared, and this was transmitted. Many of the most famous breeds of sheep and cattle have arisen through the accidental appearance of some striking peculiarity of structure, which has been preserved by careful selection and breeding. Thus the well-known Ancon or otter breed of sheep, now extinct, arose in the last century in Massachusetts by the accidental birth of a ram characterized by crooked legs and a long back like a turnspit. These peculiarities rendered him unable to leap fences, and as this was a point of great importance to the early settlers, this ram was selected for breeding, and his abnormalities of structure were faithfully transmitted. The breeds of Mauchamp sheep and Niata cattle had a somewhat similar origin. Darwin relates how in a litter of pointer pups one was observed to be of a blue color. This remarkable circumstance led to inquiry, and it was found that, four generations earlier, there had been in the same breed a pointer bitch named Sappho, celebrated for her blue color. We have here an instance of one of the secondary laws of inheritance known as the law of Atavism (from *atavus*, an ancestor). According to this law, any peculiarity, instead of passing directly from parent to child, may skip one or more generations, and reappear lower down in the line of descent. Of this curious law innumerable instances occur. It is not uncommon for a child to resemble his grandparents much more closely than his father or mother. This is frequently noted in the case of animals, where we have the opportunity of observing several generations, and analogy would lead us to expect a similar principle in the case of man. The law of Atavism can only be explained by assuming that the qualities which were *patent* in grandfather and grandchild were *latent* in the intervening generation. There is nothing difficult or arbitrary in this hypothesis, as multitudes of facts are on record to prove that physical and intellectual peculiarities may remain dormant for long periods in an individual, and suddenly develop into prominence under some unwonted pressure. Thus, privation or confinement in an unwholesome atmosphere may develop a latent tendency to consumption. A severe illness has been known to determine the onset of insanity, to which the individual had a hereditary predisposition ; or to take more hopeful instances, a severe shock, such as bereavement or the sudden loss of fortune, has been frequently known to bring out unexpected traits of character, and to develop a resolution and a magnanimity, of which the individual had previously exhibited no evidence. Our characters, in addition to those prominent traits which attract general attention, have a multitude of secret marks traced as it were in invisible ink, and ready to spring into prominence on condition of the necessary stimulus being applied.

When we leave the domain of structural peculiarities and turn to that of mind, habit, and instinct, we find an inexhaustible store of curious facts of inheritance. Contrary to popular belief, there seems no reason to doubt that genius is hereditary, though, from the obvious conditions of the case, it is rarely transmitted in like quality and degree from parent to child. The subject is too large to be advantageously considered here; but those interested in it will find a vast mass of striking information and ingenious reasoning in Mr. Francis Galton's admirable work on "Hereditary Genius."

A case is on record of a man who possessed the habit of sleeping on his back with the right leg crossed over the left. His daughter, while still an infant in the cradle, exhibited the same peculiarity. The possibility of imitation, conscious or unconscious, is here obviously excluded. A case has been reported to the writer of a man who had the habit of alternately flexing and extending his great toe while lying in bed. His grandson developed the same habit, though quite ignorant of his grandfather's peculiarity. Ribot records a curious instance of a domestic servant who exhibited an incurable vice of loquacity. She talked incessantly to any one who would listen, to animals, to inanimate objects, and even to herself. When upbraided with her folly, she said it was not her fault, as her father had possessed just the same habit, and had almost driven her mother distracted by it!

Instinct is strongly hereditary in animals, even under the most unfavorable conditions. Ducklings hatched by a hen take to water immediately on breaking their shell; and every one is familiar with the spectacle of the distracted mother wildly running to and fro on the margin of the duck-pond, while her youthful family, heedless of her terror, disport themselves delightedly upon its surface. If the eggs of the wild duck be placed under one of the domesticated species, the young, when their feathers are complete, immediately take to the wing. Birds hatched in confinement construct in their cages the same kind of nest as their more fortunate brethren of the same species build in the virgin forest. Many curious and apparently mysterious facts are explicable on the hypothesis of the permanence under changed conditions of traces of aboriginal instincts. Thus, the domesticated dog, even when thoroughly well cared for, is very fond of burying a bone in some secret spot—a lingering trace, probably, of the time when he ran wild in the woods, and the secreting of surplus food for a future occasion was a matter of practical importance to him. When the squirrel is reared in confinement, it stores away in a corner of its cage a portion of the nuts supplied to it, an instinctive preparation for the coming winter, unnecessary, indeed, for this individual squirrel, but highly important for its ancestors and congeners living in the wild state. Every one must have observed how difficult it is to make the common ass leap over a stream, however small. This unwillingness is not the result of an inherent incapacity for jumping, as the ass leaps over other obstacles with ease, while it hesitates obstinately at the tiniest streamlet. We have here, in all probability, a remnant of an instinct dating far back to the time when the ancestors of the ass were exclusively desert animals, and so unaccustomed to the sight of running water as to be confused and terrified by it. If any one observes a field of lambs at play, he will notice with what delight they frisk upon any hillock within their reach. Here we have probably a trace of the time when the progenitors of our sheep were Alpine animals, and possessed the habits of the chamois.

In the realm of disease, the facts of inheritance are most numerous, and are daily accumulating. Here they are no longer, alas, curious and amusing, but terrible, fateful, overwhelming. No fact of Nature is more pregnant with awful meaning than the fact of the inheritance of disease. It meets the physician on his daily rounds, paralyzing his art, and filling him with sadness. The legend of the ancient Greeks pictured the malignant Furies pursuing families from generation to generation, and rendering them desolate. The Furies still ply their work of terror and death ; but we have stripped them of the garb which superstition threw around them, and they now appear to our eyes in the more intelligible but not less awful form of hereditary disease. Modern science, which has cast illumination into so many dark corners of Nature, has shed a new and still more lurid light on the words of the Hebrew Scripture : "The sins of the fathers shall be visited upon the children unto the third and fourth generation." Instances of hereditary disease abound on every hand. Fully fifty per cent of cases of gout are inherited. The proportion is not much less in that fell destroyer of families, our national scourge, consumption. Cancer and scrofula run strongly in families. Insanity is hereditary to a marked degree ; but fortunately, like many other hereditary diseases, tends to wear itself out, the stock becoming extinct. Nearly all defects of sight are occasionally inherited. Sir Henry Holland says truly that "no organ or texture of the body is exempt from the chance of being the subject of hereditary disease." Probably most chronic diseases which permanently modify the structure and functions of the body are more or less liable to be inherited.

The important and far-reaching practical deductions from such facts—affecting so powerfully the happiness of individuals and families and the collective welfare of the nation—will be obvious to reflective minds, but can not be dwelt upon in the present article.—*Chambers's Journal.*

An Austrian official report on over-pressure in the public schools recommends as a remedy for the evil, which is pronounced real, a better division of the holidays by giving longer vacations at Christmas and at Easter; and suggests the doing away of the abuses of requiring written exercises, and the committing of too much to memory. Dr. Joseph Heim insists that, whatever reform is adopted, should include the consulting of the physical no less than the mental growth of the young.

SKETCH OF HENRY BRADFORD NASON.

HENRY BRADFORD NASON, Professor of Chemistry and Natural Science in the Rensselaer Polytechnic Institute, Troy, New York, was born in Foxborough, Massachusetts, June 22, 1831, but removed to North Bridgewater when ten years of age. His father, Elias Nason, was a descendant from Willoughby Nason, of Ipswich, Mass. (1712), and was born at Walpole, Mass., in 1768, and died at Easthampton, Mass., in 1853. He was a gentleman noted for his honesty and integrity, and was long engaged in the manufacture of straw and cotton goods; carried on mercantile business; and served his town, Foxborough, as justice of the peace and as Representative in the General Court. The Nasons were living at Stratford-on-Avon in the days of Shakespeare, and a branch of the family still reside there. Professor Nason's mother, Susannah (Keith) Nason, was a lineal descendant from the Rev. James Keith, who was educated at the University of Aberdeen, Scotland, and was the first minister of North Bridgewater (now Brockton), Mass. Having attended school for a short time at Newburyport, young Nason entered the Adelphian Academy at North Bridgewater, in 1843, where his attention was drawn to the study of natural science, and he began to make collections of the local minerals. While attending the Williston Seminary, which he had entered in December, 1847, his taste for natural science grew; he became interested also in chemistry, and enriched his collections with rare and valuable plants and minerals. He cultivated these studies still more assiduously at Amherst College, where he visited the interesting geological points in the Connecticut River Valley; and, under the guidance of Professor Shepard, spent most of his vacations in the mineralogically rich regions of western Massachusetts and Connecticut, making many of his expeditions on foot or on horseback. He studied analytical chemistry under Professor Clark, and assisted him in the preparations for his lectures. Having been graduated from Amherst in 1855, he went to Europe, and was matriculated in the Georgia Augusta University at Göttingen, as a student of philosophy. Here he gave special attention, "with a right good-will," to chemistry, mineralogy, geology, and the German language. He afterward spent some time, greatly to his profit, with Bunsen at Heidelberg, and Plattner at Freiberg. Having returned home, enriched with many specimens of rare minerals and of art, he was appointed, in March, 1858, Professor of Natural History in the Rensselaer Polytechnic Institute. In the following September he was elected Professor of Chemistry and Natural Science in Beloit College, Wisconsin. He divided his time between these two institutions till 1866, when he resigned the position at Beloit, in order to accept the professorship of Chemistry and Natural Science at Troy. After a second visit to Europe, he made a tour of geological study in the Southern States in the spring of 1860. In the next year he traveled through Ireland, Scotland, Holland, Belgium, and a part of Germany, and spent a semester in Göttingen in the study of geology and mineralogy, under Walterhausen. He then visited and studied the volcanic regions of Italy, ascended Mount Vesuvius, explored the regions of the solfatara, climbed Mount Etna, examined the glaciers of Switzerland and the configuration of the Alpine regions; and, in France, inspected the natural curiosities of the Puy-de-Dôme. In 1872 and 1875 he made three visits to California, in the course of which he traveled in Nevada and Idaho, and the mining regions of Colorado and Utah, and included in his third trip the Yosemite Valley. He spent the summer of 1877 in northern Europe—Finland and Russia—when he enjoyed as a privilege the traversing of the fields which Linnæus had explored for material for his great botanical work. In the next year he was appointed by President Hayes juror for the United States at the Paris Exposition, and was assigned to the department of mineralogy. Having engaged, in 1880, in the service of an oil company as chemical adviser and expert, he has since devoted much time and attention to the refining of petroleum, methods of testing, and the composition and analysis of crude oils. In the course of these investigations he has been able to throw considerable light on the important subject of the prevention of the nuisances arising from the processes of treating petroleum. In 1881 the New York State Board of Health selected him to be inspector of petroleum-oils, and appointed him a commissioner to London to consider methods of dealing with petroleum nuisances. Another visit to northern Europe, in the summer of 1884, embraced the fiords and glaciers of Norway, and was extended to the North Cape.

Professor Nason's published works include an "Inaugural Dissertation on the Formation of Ether" (1857); "Table of Reactions for Qualitative Analysis" (1865); a translation and revision of Wöhler's "Hand-Book of Mineral Analysis" (1868); "Table for Qualitative Analysis in Colors" (1870); an edition of Elderhorst's "Manual of Blowpipe Analysis" (1873, followed by fourth and fifth editions in 1875 and 1876); an edition of the "Manual of Blowpipe Analysis and Determinative Mineralogy" (1880); and a semi-centennial catalogue, the "Proceedings of the Semi-Centennial Celebration," and a "Biographical Record" of Rensselaer Polytechnic Institution. Besides receiving numerous college and university honors, Professor Nason has been elected Fellow of the American Association for the Advancement of Science; Fellow of the London Chemical Society, and of the Society of Chemical Industry; member of the American Chemical Society, of the New York Academy of Sciences, of the American Institute of Mining Engineers, of the Troy Scientific Association; an honorary member of the Albany Institute; and a member of the "Norske Turistforenings," of Christiania, Norway.

Professor Nason, although, as we have seen, he has made a quota of contributions in the way of special studies and publications to the spread of scientific knowledge, is best known as a teacher; and many hundred men, now earnestly at work in fields of engineering and scientific activity, can trace the beginnings of their usefulness and professional devotion to the enthusiasm which they drew from his instructions and example. His assiduous industry and constant labor to improve and develop the educational facilities and appliances of the seminary have contributed no little to the growth of the solid and world-wide reputation which the Rensselaer Polytechnic Institute enjoys. The marks of his work are especially seen in the laboratory, with its three departments—metallurgical and chemical rooms and lecture and study rooms—affording experimenting accommodations for forty students, which was planned and built under his direction. After the mineralogical cabinet of Professor Eaton, which had been rearranged and labeled by Professors Hall and Nason in the previous year, was destroyed by fire in 1862, Professor Nason, who was then in Europe, immediately began collecting the nucleus of a new cabinet, and this is now known as the Henry B. Nason collection of minerals, containing five thousand specimens, which are arranged in several divisions to illustrate their structural, physical, and chemical properties. His name is also closely associated with the botanical rooms, in which one of the special features is a collection of more than three thousand specimens of American and European plants presented by him. As a teacher, he possesses in a high degree the power of inspiring the minds of his students with a love of science for the sake of science. In consequence of his faithful attention to the drilling of the lecture-room, this work absorbing his time and being honored by him as his duty of paramount importance, he has not been as fruitful in the publication of original investigations and the announcement of the new discoveries which he is so competent to search for, as he might have been had he divided his attention more equally between the two branches of his work. His methods of teaching are quiet, analytical, simple, and winning. An eminent writer has said of him: "He is, in my opinion, one of the most competent scientific instructors of our country; he brings to his classes in the laboratory enthusiasm for their inspiration, rich stores of scientific learning for their enlightenment, and is, in himself, in respect to good nature, gentleness of manner, and elegance of language, a model of what they should be." If the workman may be known by his work, the hundreds of engineers and scientific experts who have enjoyed the tuition of Professor Nason are the best evidence of his ability as a teacher.

CORRESPONDENCE.

PROFESSOR HUXLEY AND THE "BLIGHTED FIG-TREE."

Editor Popular Science Monthly:

IN "The Popular Science Monthly" for January, Professor Huxley, writing on "Science and Veracity,"* says: "I do not know any body of scientific men who could be got to listen without the strongest expressions of disgusted repudiation to the exposition of a pretended scientific discovery, which had no better evidence to show for itself than the story of the fig-tree that was blasted for bearing no figs when 'it was not the season of figs.'"

Now this very ignorant fling at Christianity is a fair specimen of the objections generally offered by infidels and semi-infidels. Coming as this does from a man of more gentlemanly instincts than Ingersoll, it lacks much of the impudence of Ingersoll, but it shows the same utter ignorance of the great subject, for Huxley here has shown himself ignorant of the facts in the case by most absurdly assuming that a fruitful fig-tree would only have fruit on it at "certain seasons"; whereas all who know the facts know that the fig-tree in Palestine should have figs on it at all seasons. Hence Professor Huxley's fling has no base on which to rest. It is a sad pity in the interests of mankind, and especially of these men, that they are not willing to give as fair tests of the truths of Christianity as they give to chemistry and other sciences. If they could be persuaded to apply the adequate tests to the claims of Christianity which Christ gave, when he said, "If any man will do his will, he shall know of the doctrine whether it be of God," they would thus have ample proof of all the important claims, and would "know of the doctrine," and, as the greater includes the less, the importance of all these little mysteries would vanish.

Professor Huxley undoubtedly understands much about physical sciences (geography excepted, apparently). But, manifestly, he knows nothing about the science of religion.

He thereby falls into the grossest absurdities in attempting to write of it as Professor Tyndall did in his quintessence of absurd impudence, when he proposed to test the spiritual efficacy of prayer by a steel spring, which proposition is as far and no further from reason than Professor Huxley's assumption is from facts.

J. W. HUNTOON, M. D.

LOWELL, MASSACHUSETTS, *January* 12, 1888.

* "Science and the Bishops."

The obvious comment on the foregoing is, that it affords a "fair specimen" of the proneness of many people, in their extreme solicitude for the safety of favorite beliefs, to see all sorts of bugbears, where to a cooler judgment there is not the slightest occasion for alarm. The passage so excitedly complained of as "this very ignorant fling at Christianity," "a fair specimen of the objections generally urged by infidels," and as showing "utter ignorance of the great subject" is quoted by Professor Huxley from a source that should command the confidence instead of the contempt of our correspondent. For the convenience of the reader we give the passage as it occurs in the Gospel of St. Mark, chapter xi, verses 13, 14.—EDITOR.

"And seeing a fig-tree afar off, having leaves, he came, if haply he might find anything thereon: and when he came to it, he found nothing but leaves: for the time of figs was not *yet*.

"And Jesus answered and said unto it, No man eat fruit of thee hereafter forever. And his disciples heard *it*."

THE INTERSTATE COMMERCE LAW.

Editor Popular Science Monthly:

In your February number there is an article by Mr. Henry Wood on the "Interstate Long and Short Haul," containing some errors of fact which may bear correction. The clause of the Interstate Act which forbids an aggregate larger charge for a shorter than for a longer distance over the same line, under substantially similar conditions, receives severe criticism, and in illustration of its alleged bad effects several instances are mentioned. It is stated (page 540) that the rail-carriers between New Orleans and New York or Boston are not allowed to quote rates in competition with water carriers lower than to intermediate points. This is a mistake; all water competition is considered sufficient excuse for violations of this short-haul section, and the tariffs of our railroads are full of such instances: New York to New Orleans or Mobile, New York to Wilmington, North Carolina, etc., are a few out of many where interior rates are much higher.

Again, in his foot-note (page 541), Mr. Wood complains that the Canadian Pacific competes with our transcontinental roads, which are prevented by this law from accepting a less rate for a longer distance. This is also an error. Our Pacific roads made a lower through rate from San Francisco to Omaha than to Denver or Lincoln, Nebraska, expressly to compete with their Canadian rival, and complaints against them for this very thing are on file before the Interstate Commission. In their decision upon this short-haul question in the Louisville and Nashville case, the commission recognize three reasons for disobeying the general principle: (1) water competition, (2) foreign competition, and (3) such a position of railroads as would destroy competition if condemned. In regard to this latter excuse there are also illustrations in our tariffs. The Erie Railway makes the same or lower rate from New York to Pittsburg *via* Youngstown, Ohio, than from New York to Youngstown. The Michigan Central quotes a rate of thirty-nine cents from Buffalo to Goshen, Indiana, through Detroit, while charging forty-one cents per hundred to Miles, Michigan, a town thirty miles nearer. This comes through competition with the Lake Shore road, which is the short line from Buffalo to Goshen, while the Pennsylvania Railroad is the short line between Pittsburg and New York.

Into the general question of such a law I do not now enter; but are not the facts which I have given, and which could be multiplied, sufficient to show that the injurious effects of the short-haul prohibition are greatly exaggerated in the article referred to? And is it unfair to ask that something more definite be stated before accepting so sweeping a condemnation?

THOMAS L. GREENE.

NEW YORK, *January*, 1888.

EDITOR'S TABLE.

DARWIN'S EDUCATION.

NO part of Darwin's biography is more interesting than the pages which tell how his powers first manifested themselves, and how they were educated. He shared the opinion of his cousin, Francis Galton, that talent is due to Nature rather than nurture, to innate ability more than to education. Crediting then to Nature Darwin's wonderful aptitude for observation and for protracted pondering over observed facts until they became digested into laws, it is instructive to note how badly his formal education was adapted to draw out and develop his powers. Formal education, we say, for what is statedly taught is fortunately but a small part of what is really learned. Darwin's teaching and training were the best current in his boyhood and youth, the best which a wealthy and most intelligent father could provide him, and this is his comment on his first school: "Nothing could have been worse for the development of my mind than Dr. Butler's school, as it was strictly classical, nothing else being taught, except a little ancient geography and history. The school as a means of education to me was simply a blank. During my whole life I have been singularly incapable of mastering any language. Especial attention was paid to verse-making, and this I could never do well." At Edinburgh University, where he spent two years, the instruction was wholly by lectures; these he found intolerably dull, with the exception of those on chemistry. When he went to Cambridge, the recollection of the Edinburgh lectures was so strong upon him that he did not attend Sedgwick's course. This he afterward much regretted, as it seriously belated his study of geology. He, however, derived great advantage from Professor Henslow's lectures on botany; these he much admired for their extreme clearness and fine illustrations. Otherwise, his incapacity for mathematics and languages made his Cambridge studies unprofitable. When a boy, Darwin was a collector of shells, seals, coins, and minerals; at Cambridge his passion for collecting began to be purposeful, and he confined himself to gathering insects. While his formal education was so meager, his real education was proceeding apace, mainly through friendly intercourse with eminent teachers and promising students of the university, attracted by his charms of mind and manner.

Since the years of Darwin's early life much has been done to improve educational methods, and yet more remains to be done. School, college, and university courses are no longer confined to oral instruction, to language-learning and book-lore. It is found that the direct study of Nature is quite as valuable as the memorization of printed pages, or the ability to write in Latin or Greek. Natural science is vindicating its claim to discipline the important faculties which the study of mere verbal symbols neglects. To Darwin, the ability to describe a cirripede in seven languages would have been an accomplishment of doubtful value; to find the cirripede's place in Nature was an important and attractive task. He improved his faculty for observation by assiduous exercise until it became of marvelous keenness. His delight was in receiving impressions direct from Nature, not in receiving impressions of impressions, such as words convey. His rending and parting of books in his library, regarding them simply as so much material, was thoroughly characteristic.

Darwin's school and university experience emphasizes again the utter inadequacy of any education which makes too much of words — especially the words which only live in lexicons. Because language is a noble faculty, and verbal expression is a power of high importance which can be conspicuous in manifestation, utterance has been vastly overrated in schemes of education. After all, what can be verbally expressed is but a small part of what can be thought, or felt, or done. Who can describe the individualities of tone by which one recognizes a friend's voice, or the peculiarities of feature by which one classifies a face as English or Irish? What successful merchant or banker can fully tell why he expects truth and honesty from one applicant for credit, and the reverse from another? What judge can define wherein the manner of one witness impresses him favorably, and that of another adversely? Who can express in speech the feelings stirred by beholding sublime scenery or the starry sky? Where is set forth in print some detail of how music works its magic — now soothing to reverie, now quickening the pulse, arousing resolve and heroic emotion? In attempting to communicate art and skill, to convey impressions of form and color, language is powerless. Its dominion, though wide, has its strict limits:

> "Far out on the deep there are billows
> That never shall break on the beach."

Excessive cultivation of powers of verbal expression, excessive addiction to books, cause inevitable neglect of the education of hand, of eye and ear—of the senses which give us, when exercised, full and clear perceptions of the things about us. This neglect, by restricting observation and experiment, robs the reasoning faculty of the material out of which judgments may be rendered and new truth born. When a flower is planted and reared, dissected, classified, and sketched in its natural tints, it is known as it never is known to a mere memorizer of botanical text-books. Iron and sulphur become a student's intimate acquaintances in a laboratory; he learns hundreds of interesting facts about them, and how to recognize them in all disguises. Were he but a text-book scholar, he would know little more of them than their names. It is one thing to learn by rote the distribution in the heavens of the various constellations; it is another and deeper thing to know them as one must to track one's way across wilderness or sea. Progress in manipulative skill has in modern times not only given us truer graphic and plastic arts, it has led to important advances in physics and chemistry, and in surgery made the blind see and the lame walk. Every one who has practiced sketching from Nature has felt the reaction of growing deftness with the pencil upon the powers of observation and the appreciation of scenery. An artist sees so much more in a landscape than an ordinary observer, that he is justified in thinking that the ordinary observer scarcely sees anything at all. Darwin all his life bitterly regretted that he had not learned drawing when young; yet drawing is quite as easily learned by a boy as writing, and gives him the power of showing in a picture much that can not be described in words. Darwin also constantly lamented that he had not overcome his repugnance to dissecting, so as to practice the art and gain direct access to much valuable evidence. Yet, notwithstanding defects in his equipment, he rose, by what he calls sheer doggedness, to ascertaining through observation and thought one of the greatest laws of organic life. Tested by verbal standards, this great man would not have stood high. His verbal memory was poor. He always found it difficult to express himself clearly and concisely, yet this very difficulty was beneficial in making him think long and intently about every sentence, leading him to correct errors in observation and reasoning. He had the strongest disbelief that a classical scholar must write good English—he thought the contrary to be the case. Of literary style as an indulgence in power over words he evidently thought little; while he acknowledged the vividness of Carlyle's pictures of men and things, he questioned their truth. Darwin, by his life, more convincingly than by what he said, demonstrated the supreme value in education of addressing the senses and the reasoning powers rather than the verbal memory. Few boys are destined to be naturalists, and none may hope to be as great as Darwin; yet the lesson of his life is eloquent to every one surrounded by a world of things to be observed, of testimony to be elicited and sifted, of gaps in known truth to be bridged and filled. Because in times past the area of known truth has been vastly overestimated, and the value of language in the expression of such truth equally overestimated, written creeds, theological, political, legal, and educational, have on all sides blocked human advance.

Apropos of Cambridge and progress in the modernization of its curriculum, it is pleasant to read the recent remarks of Professor Seeley, who occupies the chair of Modern History at Cambridge. On the 10th of January, at the Congress of the National Society of French Professors residing in England, he said: "A crisis in the history of English education is upon us, in that classicism education is once more attacked, and the affirmation strongly made that the interests of practical life must no longer be neglected in our educational system, and that Englishmen must be prepared at school to compete in commerce and in business with their foreign rivals, and for this purpose they will have to renounce in part that training in Latin and Greek which former generations of Englishmen have received. The assertion is made more peremptorily, more impatiently, than ever before. I am myself by breeding a classicist of the classicists. In aim I am most heartily at one with the classicists. At the same time I think that in taking up their position they display a spirit of blind, unreasoning conservatism, such as in politics died out with Lord Eldon. What is to be done if the claims of practical life and those of culture are radically incompatible? I should say that the Master of Balliol laid the best basis for such an arrangement when he pointed out that French might be treated as a stepping-stone to Latin.

"Let us give up the preposterous doctrine that Latin must be learned in order to learn French, and let us teach French in order to teach Latin. In so doing we do not sacrifice literature to mere business, for the modern languages have literatures as well as the ancient. There exists a French literature which comprises books of poetry, devotion, philosophy, science, history, politics—a literature not less but more extensive and various than Greek and Roman literatures themselves. This literature indisputably excites the same sort of emotions and exerts the same influence as classical literature. It elevates the mind, stimulates the imagination, and forms the taste; in short, there is absolutely no good effect produced by the classical literature which is not also in some degree produced by this literature."

THE CONTRADICTIONS OF SCIENCE.

Much ado is often made by persons hostile to science or—which is the same thing—having a partisan interest in opinions which they wish to maintain in spite of science, about the contradictions that mark the development of scientific theory. Because the theories which served a good purpose a year ago, or twenty-five years ago, or a century ago, have been put aside in favor of others that more nearly meet the facts as they are known to-day, science, they argue, is not in the least to be depended on; and therefore objections made in the name of science to any opinion or set of opinions should not be allowed to carry any weight. This is a very popular line of argument, but it is also very fallacious, as a moment's consideration will show. In the investigation of Nature the mind necessarily forms theories as it goes along. Some kind of a theory is almost necessary even to observation; and the theory which, at the moment, best accounts for the facts is the one toward which the mind must incline. This is a law which no one can hope to escape. The most reasonable thing any man can do is to accept from moment to moment the soundest and most comprehensive generalization offered to his thought. If that generalization should be incomplete, or in any way unsound, the quickest way to discover its weakness is to put it to the strain of daily use. The question to ask regarding Science—the only really pertinent question—is as to whether she has not, from the dawn of rational thought, been extending her observations and improving her theories. Is she not, has she not always been, on the road to truth? Has she not already established a great many substantially true theories, and is she not daily adding to the number? If scientific men have been too confident in times past as to the absolute truth of their hypotheses, one good result at least has followed from their over confidence: their partial views have all the sooner been displaced by more comprehensive ones. But because science is progressive, because its work is never done, is it never to venture to criticise opinions that are not progressive? We say that the holder of even an imperfect scientific theory, provided it is the best obtainable at the time, has a perfect right to say to one who holds a view that embodies no scientific theory whatever, but simply contradicts all scientific theory, that he is wrong in holding that view. Grant that the view in question may be in unsuspected harmony with some higher truth or principle not yet discovered, we may still say that, in the absence of a *present* justification in fact, it is not right to hold it as true *now*. Better far to take one's humble place in the great procession that is moving steadily onward toward the goal of a true scientific philosophy, and let the higher views dawn on us in their own good time.

It is a strange accusation to bring against science that it is progressive, that it provides means, from age to age, of expressing all the truth that is at the time obtainable, while reserving full liberty to widen, as circumstances may permit, the circle of its inductions, and consequently the basis of its theories.

If this is something to be ashamed of, where is that which we should admire? The proper answer to give to those who love to point out the fallibility of scientific theories (as if elsewhere there were theories that were infallible!) is that it is better to follow any theory that, so far as our knowledge extends, affords an explanation of facts, than to make crude assertions reposing on no theory whatever. At the same time let us take home to ourselves the lesson that science *is* progressive; that the thought of to-day can not assume to bind the thought of to-morrow; and while we still prefer any rational theory to an irrational lack of all theory, let us not by any undue dogmatism give occasion to the enemies of progress to blaspheme. Science, with all the confessions it has to make of past errors, and all its admissions of probable present errors, is going bravely on. Its very errors have been relative truths, and its service has at all times been the service of truth. Can those who delight and exult in the errors of science say as much for the service, whatever it may be, in which they are engaged?

We noticed, not very long ago, an extract from the article on "Brain-forcing in Childhood," contributed by Dr. Hammond to the pages of this magazine, doing duty apparently as an original article in the columns of the "Public School Journal" of Mount Washington, Ohio. In the January number of the "Canada Educational Monthly," published at Toronto, Ontario, there appeared two of our own editorial articles, one entitled "Culture and Character," the second "Encroachments of the State." The first is duly acknowledged, the second is not. It is quite possible that neither of the journals mentioned borrowed the unacknowledged matter directly from our columns, but it is evident that the journal which *first* borrows without acknowledgment does a very dishonest thing, destroying as it does the lawfully acquired property of another journal in the original matter published by it. We rejoice at every sign of public notice which the "Monthly" receives, and make our contemporaries welcome within reasonable limits to whatever in our columns they may desire to reproduce; only, we should like them always to do us the justice of acknowledging what they take.

LITERARY NOTICES.

Origins of the English People and of the English Language. Compiled from the Best and Latest Authorities. By Jean Roemer. New York: D. Appleton & Co. Pp. 658. Price, $3.50.

In this book political and literary history are combined, each being treated with a nearly equal degree of minuteness, in such a manner that a fair view of the subject is presented from both sides, and the mutual influence and reactions of the ethnic and linguistic development of the English people are plainly exhibited. The author's vindication of this course—if he needed any vindication for doing his work as completely as he could—may be found in the opening sentences of his preface: "The history of a language is, in a great measure, the history of the people who speak it, and of those who have spoken it. It is the history of the many populations, different in origin, manners, and in speech, who have at various epochs occupied the soil conjointly, sometimes in friendly but more often in hostile relations, until people of another race, more powerful than any, have crushed them all, and, taking possession of the land, have divided it among themselves, exterminating all who resisted them, and allowing the rest to live only on condition of their being quiet and doing all the work." The English people and language are a conspicuous example of the product of such a series of revolutions as is here described. The course to be followed in tracing the English language to its sources involves, therefore, a critical inquiry into the origin, character, and distribution of the various races of men—Celts, Romans, Saxons, Danes, and

Normans — who at various epochs have found their way into the British Islands; their idioms and forms of religion, their social and political differences, and their relative progress in the arts of civilized life. If we go back to the beginning of this history, we must take notice of the palæolithic and neolithic men, whose part in the formation of the British people is a totally unknown factor. Still, they have left their marks on the land, and may have contributed more than we know toward shaping its future destiny. The Celts were a factor of more recognized importance, and exerted an influence which is still potent in the character of various populations and in the language. From them are inherited numerous local names; and, "although the Druids committed nothing to writing, the religion of the British tribes has exercised an important influence upon literature. The mediæval romances, and the legends, which for a long time stood for history, are full of the 'fair humanities' and figures of its bright mythology." The Romans contributed a quota, which must have been very considerable at the time, but the outward effects of which were to a large extent washed out by subsequent revolutions and invasions. So that, while English is full of what has been derived from Roman influences transmitted through factors operating intermediately in later times, it is doubtful whether any Latin word in modern English is traceable to that remote period. The visible building up of the English people and their language begins with the institution of the Saxon dominion. When Charlemagne had been crowned emperor, and was aspiring to revive the ancient Roman Empire, it was desirable to avoid complications which might arise from a supposed identity with the continental Saxons who had fallen before the great chief; and the names of *English* and *England* were adopted, in part, it may have been, "as more suitable to proclaim to the world at large a distinct nationality for all the inhabitants of England, possibly divided on minor questions, but having nothing in common with the Saxons of continental Europe." The earliest Anglo-Saxon literature originated in the conflict of Christianity with Anglo-Saxon paganism, in which not the heathen practices and ceremonies were the most formidable impediments to the progress of the Christian faith, but the kind of heathen poetry still current, by means of which the memory and practice of the ancient rites and ceremonies were kept alive in the songs at wakes and festivals. "It was to counteract this influence that the clergy composed Christian hymns and songs in the national language, which, to be effective, had to conform to the taste of the age, and to be made equal to the best poems then extant and admired by the most intelligent of those who had embraced the new religion." Among these works was the great poem of Cædmon. The Danes left their impress in local names and in changes in pronunciation, but the whole influence of their sojourn, owing to the disorders and divisions which it produced, was detrimental; and "it was impossible that in such circumstances the national character should not have become deteriorated, and that the country should not have lagged behind in the career of wealth, the arts, of literature, and of every other line of public prosperity and greatness. Accordingly, at the era of the Norman invasion, England was still a country of no account on the political map of Europe." This event, marking a new departure in the career of the English nation, is, with all that relates to it, treated with fullness of detail in its historical, linguistic, and literary aspects. The earlier history of the Normans is given. The conquest is related. The growth of the Norman-French language in England was followed, after the separation of Normandy, by its decline. Then occurred the fusion of the Anglo-Norman French and Anglo-Saxon English, the progress of which is carefully recorded. The last chapter in this department of the work is upon "The English Language and its Vocabulary"—that is, the development of the language as a self-contained entity—which is treated in a manner similar to that in which the other subjects are considered. The history is illustrated by collections, in separate chapters, of specimens of Anglo-Norman French and of early English, both arranged chronologically to show the changes that took place consecutively in the two languages during the course of the evolution. It is supplemented by an appendix treating of "French

Sources of Modern English," in which are given an historical sketch of the French language and a chapter on its etymology, followed by specimens of early French. Though it is subordinate to the main purpose of the book, the execution of this department is equally satisfactory with that which characterizes the part more closely related to the English evolution. The whole book, so far as our cursory examination allows us to judge of its merits, bears the marks of conscientious research, and of a desire to be careful in statement and omit nothing that might contribute to a clear comprehension of the whole story which it tells and of every part of it. So full a presentment of the facts which it comprises, in their bearings upon one another, can not be so conveniently found in any other one book with which we are acquainted.

Weather. A Popular Exposition of the Nature of Weather-Changes from Day to Day. By the Hon. Ralph Abercromby. "International Scientific Series," Vol. lviii. New York: D. Appleton & Co. Pp. 472. Price, $1.75.

There is no class of natural phenomena which compels such general and constant interest as that which constitutes weather. The number and importance of human affairs which are affected by rain, snow, and hail, winds, lightning, heat, and cold, make a knowledge of the laws which govern weather-changes extremely desirable. Although the need of this knowledge has been felt from the earliest times, it is only within twenty years that the science of meteorology has advanced so far as to be of much practical benefit. But now that weather-predictions are issued by the governmental bureaus of the United States and other countries, and prove true four times out of five, a wide-spread desire has arisen to know how this baffling problem of the weather has been so far mastered. To satisfy this desire is the object of the present volume. "Many books," says the author, in his preface, "have been written on storms and climate, but none on every-day weather. The whole of this work is devoted to weather, in the tropics as well as in the temperate zone." The more elementary parts of weather-science are treated in the first three chapters, the rest of the book being devoted to explaining the more difficult questions. "This volume is not a mere compilation of existing knowledge, for the results of many of the author's original and unpublished researches are included in its pages—such, for instance, as the explanation of many popular prognostics; the elucidation of the general principles of reading the import of cloud-forms; the classification of those cases in which the motion of the barometer fails to foretell correctly the coming weather; and the character of that kind of rainfall which is not indicated in any way by isobaric maps." In the elementary portion of the book the author tells how weather-charts are made and what they teach, and shows why popular weather-signs sometimes prove true and sometimes fail. He also describes here the various forms of clouds, and notes the prognostics to be drawn from them. In the advanced chapters there is a further discussion of lines of equal barometric height, which is followed by a description of the making and use of the records of the barometer, thermometer, and wind-gauge. The nature of squalls, thunder-storms, blizzards, barbers, pamperos, and tornadoes is next explained. Some account is then given of local, diurnal, annual, and secular variations of weather.

In the last three chapters of the book the manner in which the individual weather disturbances follow one another, and the forecasting which depends on knowledge of these sequences, are taken up. The chief types of weather which occur in western Europe and the United States are given in detail, and are copiously illustrated by charts. In the chapter on "Forecasting for Solitary Observers," which can never be superseded for the use of mariners and herdsmen, the author points out "the best that a single observer can do, who has his eyes to look at the appearance of the sky, and any instruments at his disposal." This chapter will interest all who have any taste for amateur work in meteorology. The forecasting by synoptic charts, as done in central bureaus having telegraphic communication with stations for many hundred miles around, is described in the closing chapter. It appears that forecasting is much easier for some countries than for others. In temperate regions, those countries are best situated which lie east of a well-observed land-area, because most disturbances in the temperate zone move from the west. Hence, the eastern United States can usually count on timely warning of approaching storms. Still, infallibility can not be expected, however favorable the locality. "It is impossible to suppose," says the author, "that we have yet nearly reached the highest perfection of which forecasting is capable, but still we know enough of the nature of the subject to say with certainty that calculation will never enter much into the science of weather-prevision. Natural aptitude and the experience of many years' study are the qualifications of a successful forecaster. In fact, meteorology is not an exact but an observational science, like geology or medicine."

A Manual of North American Birds. By Robert Ridgway. Philadelphia: J. B. Lippincott Company. Pp. 631, with 124 Plates, containing 464 Outline Drawings of the Generic Characters. Price, $7.50.

This noble book, embodying descriptions of all the birds known to frequent the United States, was originally projected by Professor Spencer F. Baird, who had collected, in sympathy with its purpose, the great cabinet of American birds now forming a part of the National Museum. The pressure of official duties which fell upon him prevented his completing the scheme, or even carrying it on. The task—or "the privilege," as he expresses it—of continuing the work then fell to the present author, who is known as an enthusiastic naturalist, and especially interested in birds. He has endeavored to make of it such a manual as its projector would have desired to see as the fruit of his conception. The object of the volume is to furnish a convenient manual of North American ornithology, reduced to the smallest compass by the omission of everything that is not absolutely necessary for determining the character of any given specimen, and including, besides the correct nomenclature of each species, a statement of its natural habitat, and other concomitant data; to provide a handy book for the sportsman and traveler, as well as for the resident naturalist. The greater part of the material on which the work is based has been furnished by the collection of American birds and their eggs which forms a part of the National Museum. The collections of the American Museum of Natural History, in New York city; of the Academy of Natural Sciences, of Philadelphia; of the Boston Society of Natural History; and of the Museum of Comparative Zoölogy, at Cambridge, Massachusetts, have also been consulted; and acknowledgment is made that the private collections of George N. Lawrence, of New York city; William Brewster, of Cambridge, Massachusetts; and H. W. Henshaw, of Washington, have furnished indispensable material in the way of extra-limital species or more extensive series of certain species. Not consultation of specimens alone, however, has been depended upon; "for, however much the proper discrimination of species and subspecies may be a question of material, a great deal depends upon our knowledge of the birds in life, their natural surroundings, and other things which can be learned only out of doors. Fortunately, a very large number of accomplished field-naturalists have carefully observed the habits of our birds, and through their published records have together contributed a vast store of information which no single person could himself have gained. To the much that has been gleaned from this source have been added the author's field-notes, collected during the period extending from a recent date back to the year 1863, and embracing many measurements of fresh specimens, notes on location of nests, first colors of bill, eyes, feet, etc., and various other useful memoranda." It is intended to embrace the North American species, as they are included within the geographical limits defined in the American Ornithological Union's check-list. But it has at the same time been deemed desirable to include certain extra-limital species from contiguous countries; such as those which are known to inhabit Socorro Island, off the coast of northwestern Mexico, which is North American in its zoölogical affinities; those species which have been included for the sake of comparison, or on account of the greater or less probability of their occurrence within the southern boundary of the United States; and certain "high-sea" species whose wanderings may make them liable to reach our coasts as "accidental visitors." The body of the manual—which is preceded by a "Key to the Higher Groups"—consists of technical descriptions of the orders, families, genera, and species, in the general order of diving-birds, swimmers, waders, shore-birds, gallinaceous birds, pigeons, birds of prey, parrots, etc.; cuckoos, woodpeckers, etc.; goat-suckers and swifts, and the perching birds. The appendix gives additional memoranda concerning certain rare or little-known species, and lists of new genera and species, and of genera and species admitted as North American which are not included in the American Ornithological Union's check-list. The index gives a reference to every genus and species described, under both its scientific and its popular name.

Introductory Steps in Science. For the Use of Schools. By Paul Bert. Translated by Marc F. Vallette. Revised and enlarged by John Mickleborough. New York: D. Appleton & Co. Pp. 363. Price, $1.50.

One of the greatest obstacles with which the new scientific education has had to contend is a lack of text-books embodying the true spirit of scientific teaching. This lack is now being rapidly supplied, in each of the several branches of science, with books adapted to pupils of various needs and states of advancement. The present volume is designed as a first book in science for young pupils. The study of Nature is especially fit for the training of the young. In the words of the preface to this book: "It is a well-recognized fact that the cultivation of the sense-perceptions lies at the foundation of all knowledge. These sense-perceptions are converted into knowledge under two conditions: first, by observing differences; second, by observing likeness or similarity." It is in early childhood that the exercise of the senses is most active and most pleasurable. A little training in proper methods of observation at this time is worth more than months spent in memorizing scientific facts at a later period. As the child's interest is not confined to animals, plants, or rocks, to physical, chemical, or physiological phenomena alone, so this book obviously accords with natural development in presenting the elements of all the common branches of science before the pupil is required to pursue advanced study in any one. The work consists of seven parts: Animals; Plants; Minerals and Rock Formations; Physics; Chemistry; Animal Physiology; and Vegetable Physiology. "In all departments of the book the subjects have been treated in a manner to cause the learner to *observe*, *think*, and then *express* the result of the observations in suitable language. The pernicious practice of *memorizing* the text-book, or of requiring the student to *listen*, *recollect*, and then *repeat* the formulated statement of the instructor, can not be too strongly condemned." The favor with which the French original was received is shown by the fact that over half a million copies were sold within three years. The style of the translation is conversational, adhering closely to the language of the author when this is possible. Illustrations have been supplied with a liberal hand. "In the natural history, so far as possible, American species have been substituted for foreign ones; and in the chapter on rock formations, that portion which treats of the continental development of North America has been substituted for the author's geological history of France. In short, such corrections and changes have been made as would materially enhance the value of the book in the hands of beginners in science in America."

Memoir of Fleeming Jenkin. By Robert Louis Stevenson. New York: Charles Scribner's Sons. Pp. 302. Price, $1.

This memoir, by one of the first of living English romancers, gives a breathing portrait of a very interesting man. While Fleeming Jenkin's original work in electrical science is a notable part of the world's recent advances therein, it was as a man that he was chiefly remarkable. Professor Jenkin was ardent and impulsive, with little conventional polish, the soul of honor, and a man with whom honesty was a passion. He found in his engineering work a noble opportunity for his love of exactitude and thoroughness. He exemplified how supremely ethical are the tasks of applied science in the demands made on its votaries. During his long voyages, while he was busy laying and recovering ocean-cables, he showed himself capable of the heroic, with all the added charm of being unconscious about it. And amid all the anxious demands of professional emergencies, domestic affections of the tenderest were never absent from his mind. With him, all the powers of an acute, able intellect were heightened and warmed by a fine emotional nature. The death of several children in a friend's family, through bad drainage, directed his sympathetic interest to the question of wholesome plumbing. As the result of his investigations, he became convinced of the necessity for thorough-going reform. In 1878 he accordingly established in Edinburgh the first sanitary association ever formed, and which has not only had many imitators in Great Britain and America, but done much to convince the public of the strict preventability of a large class of dangerous maladies. This volume has added interest, in that it is to some extent autobiographical of its author, Mr. Stevenson. He shows us incidentally and unwittingly how he has become so thoroughly grounded in his art. His imagination is supplied with clear impressions of actual men; in faithfully observing whom, nothing, however apparently trivial, is neglected. His discriminating judgment and quick sympathy are quite as evident as this faculty of keen observation. The way in which he unravels the skein of his friend's heredity is masterly.

The Education of Man. By Friedrich Froebel. Translated and annotated by W. N. Hailman, A. M. "International Education Series," Vol. V. New York: D. Appleton & Co. Pp. 332. Price, $1.50.

This work is one of the educational classics with which every teacher should be familiar. Although dealing with first principles, it is not a mass of untested theorizing, but comprises the reasons for the practical method which the experience of a great teacher proved to be successful in the school-room. Froebel's aim is that the pupil shall be educated by self-exertion, beginning with that activity which, while easy and attractive, leads him forward in a continuous development of his powers. In this volume, originally designed as the first of a series, we find the fundamental ideas of the system of methods and appliances to which, fourteen years later, the author gave the name "Kindergarten." The earlier portion of the work deals with general principles, and considers the development of man during infancy and boyhood, the most important doctrines being contained in the first two chapters. In the latter part the chief subjects of instruction are taken up in the four classes: religion, natural science and mathematics, language, art. This is followed by a discussion of the connection between school and family. The translator has inserted at many points biographical and other illustrative notes, and includes in his preface the essential parts of the interesting report on Froebel's Institute at Keilhau, made in 1825, by Superintendent Zech.

Animal Life in the Sea and on the Land. By Sarah Cooper. Illustrated. New York: Harper & Brothers. Pp. 413. Price, $1.25.

This very attractive book is designed as an introduction to the study of zoölogy for children. While accuracy and freshness have been aimed at in its pages, scientific terms have been avoided as much as possible. In classification, which has not been made prominent, the arrangement of Nicholson has been followed. In arrangement, the ascending scale is pursued, beginning with sponges and ending with man. Such animals as are most likely to interest young people have been selected to illustrate the several orders and classes. Of the study of animals, the author says, very properly, in her preface: "It is far more charming to gain this knowledge from the objects themselves than from merely reading about them in books; and it is therefore hoped that each subject which is treated in these pages will be studied from specimens actually in hand, whenever it is possible to obtain them." A very good substitute for unobtainable specimens is afforded by the abundant and clear illustrations.

Outlines of Natural Philosophy. For Schools and General Readers. By J. D. Everett. New York: D. Appleton & Co. Pp. 335. Price, $1.

This little volume, by the editor of that standard work, Deschanel's "Natural Philosophy," is designed to be easy enough for a class reading-book, and precise enough for a text-book. It is written in the continuous style of a general treatise, instead of being cut up into detached paragraphs like a common school-book. Although the book is elementary, its language is adapted to the adult reader and the academy or college student, rather than to the young pupil; but technical terms have been avoided, and algebraic formulas have been altogether excluded. The descriptions are uniformly clear, and are made more effective by abundant illustrations.

Childhood: Its Care and Culture. By Mary Allen West. Illustrated. Chicago: Woman's Temperance Publication Association. Pp. 772.

The moral and physical culture of children is treated in this large volume, especial prominence being given to religious teachings. The mental culture which is more properly received at home than in school is also touched upon. The book is embellished with pictures, poetry, stories, and music.

A History of Elizabethan Literature. By George Saintsbury. London and New York: Macmillan & Co. Pp. 471. Price, $1.75.

This book is intended to be the second of a series of four volumes, by different authors, together comprising a history of English literature. The period covered in the present volume is from 1560 to 1660. The large number of writers noticed seems to leave nothing to be desired on the score of completeness. Illustrative extracts are given from all the important ones excepting the four best known.

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The Havre de Grace Republican Illustrated Almanac for 1888. Havre de Grace, Md. Pp. 80.

Gilman, D. C. A Plea for the Training of the Hand: Belfield, H. H. Manual Training and the Public Schools. (Monographs of the Industrial Educational Association. Vol. I, No. 1.) New York: Industrial Associations. Pp. 24. 25 cents.

Clapp, Charles, Cincinnati. The Present Truth for the Honest Inquirer. Pp. 20.

Brinton, Daniel G., M. D., Philadelphia. On the so-called Alaguilac Language of Guatemala. Pp. 12. On an Ancient Human Footprint from Nicaragua. Pp. 8, with Plate.

Woman Publishing Company, New York. "Woman: A Monthly Magazine." Vol. I, No. 2. January, 1888. Pp. 78. 25 cents, $2.75 a year.

Wilde, Oscar. "The Woman's World," January, 1888. Pp. 48. 35 cents, $3 50 a year. New York: Cassell & Co.

Hill, Robert T. The Texas Section of the American Cretaceous. Pp. 24.

Gerry, Elbridge T., and others. Report of the Commission to investigate and report the most Humane and Practical Method of carrying into Effect the Sentence of Death in Capital Cases. To the Legislature of New York. Pp. 100.

Treat, E. B., Publisher. The "Don't forget it Calendar" for 1888. New York. 20 cents.

Hicks, Lewis E., Lincoln, Nebraska. Irrigation in Nebraska. Pp 32.

Smithsonian Institution. Report of Spencer F. Baird, Secretary, for 1886-'87. Washington: Government Printing-Office. Pp. 27.

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POPULAR MISCELLANY.

The Panama Canal.—At the meeting of the Academy of Sciences held in Paris, January 9, 1888, M. Ferdinand de Lesseps made a communication in relation to the proposed changes in the Panama Canal, of which the following account is taken from the "Journal des Débats": "What is now being done—and this will enable the largest vessels to pass from one ocean to the other in 1890—is the ship-canal just as it was agreed upon by the International Congress, and just as it should be on the original line; only, instead of waiting until it shall be completely finished, in order to open it to navigation, we have simply decided to do again that which was considered best for the Suez Canal in 1865—that is, at a time when formidable opposition, both political and financial, particularly financial, threatened to ruin the enterprise just as it was about to be finished. We have merely decided to open the canal to navigation as soon as possible when we shall be able to have ships as large as those of the Transatlantic Company pass from one ocean to the other, and a sufficient number of them to bring the annual traffic up to seven and a half million tons, as was predicted by the International Congress. This traffic assures us an annual revenue of one hundred and twenty million francs; it will enable us to settle all our indebtedness, and to pay a first dividend on the shares, and will still leave us something over. It is just as this surplus will increase that we shall complete the canal without any one feeling the expense, and without stopping the regular increase of the dividends, exactly as has been the case at Suez. But, in order to open the Panama Ship-Canal to the navigation of large vessels before it is finally completed, the problem is to hold the water in the parts of the canal not yet dug to the requisite depth in what engineers call upper basins ("biefs supérieurs"); to hold the water there, and at the same time allow ships to pass in and out of these basins, we shall have to construct metallic doors as for locks, like those seen in all harbors where there is a rise and fall of the tide, and in ocean harbors. Mr. Eiffel, at my request, is to take charge of this work, for which his experience, his scientific knowledge, and the great works of this kind he has undertaken and always succeeded in, naturally pointed him out beforehand as my assistant. That is the whole story. So, it is the future tide-level ship-canal at Panama that will continue to be dug; it will be laid out in a way to accommodate the traffic of the world, and be continued and completed much sooner than is supposed, although the traffic of seven and a half million tons calculated by the International Congress is actually more than ten million tons. The profits will soon be great enough to enable the canal to be finally completed with little delay, and at no further expense, as it will pay for itself."

Opinions about the Mound-Builders.—In explaining the methods of the Bureau of Ethnology in mound-exploring, Dr. Cyrus Thomas mentions three plans on which the work might be done that are worthy of consideration. The first is the systematic plan, under which all the ancient works should be surveyed and mapped, and then thoroughly explored and investigated; the second is the local plan, which begins with a limited locality and confines operations to it until the investigation of it is completed; and the third is the comprehensive plan, or plan of general study, in which the chief objects are to search for and study the various forms and types of the works and minor vestiges of art, and to mark out the different archæological districts as disclosed by investigation. This plan permits the carrying on of operations at various points simultaneously, or removal from place to place as the types and forms of a section are satisfactorily determined. The first of these plans is regarded as the most systematic and scientific, and the second as next so. Yet circumstances have made it expedient for the Bureau to adopt the third, which promised to yield the results that were most immediately demanded, more expeditiously and at less cost than the others. The question most prominently kept in view was that whether the mound-builders were Indians. From the data so far obtained, the conclusions appear to be justified that the mound-builders, in the area to which especial attention has been given, consisted of a number of tribes or peoples bearing about the same relation to one another and occupying the same culture status as the Indian tribes inhabiting the country when it was first visited by Europeans; that nothing trustworthy has been discovered to indicate that these tribes belonged to a highly civilized race, or that they were a people who had attained a higher culture status than the Indians; that the links discovered directly connecting the Indians and mound-builders are so numerous and well established that there should be no longer any hesitancy in accepting the theory that the two are one and the same people; that the statements of the early navigators and explorers as to the habits, customs, circumstances, etc., of the Indians when first visited by Europeans, are largely confirmed by what has been discovered in the mounds and other ancient works of our country; that the evidence obtained appears to be sufficient to justify the conclusion that particular works and the works in certain localities are to be attributed to particular tribes known to history; that the testimony of the mounds is very decidedly against the theory that their builders were Mayas or Mexicans; and that evidences of contact with Europeans are frequent and authentic enough to make it probable that a goodly number of the mounds were built subsequently to the discovery of the continent by Europeans.

Some Advantages of a Fruit-Diet.—"Fruit and Fruit-Culture, as related to Health," was the subject of an address by Professor H. W. Parker before the Iowa State Horticultural Society, in which working among fruit and living with it are commended to a population who become bilious on excess of meat. In temperate zones, the author says, "the dire experience of almost universal disease, and the evidence of those who have freely used fruit, point to this as a most needful article of diet; and when we come to the tropics we find that men must confine themselves mostly to fruit-diet, a practice that should be largely followed in our long, hot summers; yes, with our present habits of unwholesome living, especially in respect to confined air and cooking, must be observed in winter as well. In the warm temperate climates there are enough examples of muscular, long-lived people who live on a minimum of animal food, such as those of the Grecian Archipelago, who subsist on goat's milk, figs, and maize-bread. Individual examples are to the same effect. Dr. Winship began as an invalid, and by athletics and diet attained such vigor that he could lift twelve hundred pounds. He indulged, we are told, occasionally in sardines, and for the rest depended on fruit and farinaceous (that is, starchy) food. The recovery of health in grape-cures shows what may be sought in that direction; the peach-cure has lately come into notice, and doubtless any ripe, fresh, juicy fruit, if not of a kind too astringent or laxative in certain cases, would do as well. I can testify that a quart or two of strawberries, twice or thrice a day, soon recovered me from torpidity of the liver and consequent constipation, increasing for a year or two; and yet this is spoken of as not of an aperient sort. Since then my only medicine is fruit the year round."

Thrifty Habits of a Woodpecker.—Not many observations have been recorded of the laying up of food for future use by birds. One woodpecker, in California, is known to deposit food by digging holes in the trunks of trees and driving acorns into them till the trunks look as if they were studded with brass nails. Professor O. P. Hay observed a similar trait in the red-headed woodpecker during an unusually favorable season for beechnuts in Indiana. "From the time the nuts began to ripen," he says, "these birds appeared to be almost constantly on the wing, passing from the beeches to some place of deposit. They have hidden away the nuts in almost every conceivable situation. Many have been placed in cavities in partially decayed trees; and the felling of an old beech is sure to provide a little feast for a bevy of children. Large handfuls have been taken from a single knot-hole. They are often found under a patch of the raised bark of trees, and single nuts have been driven into cracks in bark. They have been thrust into the cracks in front gate-posts; and a favorite place of deposit is behind long slivers on fence-posts. I have taken a good handful from a single such crevice. . . . In a few cases grains of corn have been mixed with beechnuts, and I have also found a few drupes, apparently of the wild-cherry, and a partially eaten bitter-nut. The nuts may often be found driven into the cracks at the end of railroad-ties; and, on the other hand, the birds have often been seen on the roofs of houses, pounding nuts into the crevices between the shingles. In several instances I have observed that the space formed by a board springing away from a fence-post has been nearly filled with nuts, and afterward pieces of bark and wood have been brought and driven down over the nuts, as if to hide them from poachers. These pieces of bark are sometimes an inch or more square and half an inch thick, and driven in with such force that it is difficult to get them out. In one case the nuts were covered over with a layer of empty involucres. Usually the nuts are still covered with the hulls; but here and there, when the crevice is very narrow, they have been taken off, and pieces of the kernels have been thrust in."

Alaska and its Tundra.—A contributor in the "American Field" describes Alaska as having dimensions not only in latitude and longitude—"for not a great distance from the Aleutian Islands, separating the Pacific from Behring's Sea, and in the former body of water we have the deepest sea-soundings known to science, while Mount Saint Elias cleaves the clouds for 19,500 feet, the highest mountain of the North American continent, and the highest Alpine peak in the whole world; for the line of perpetual snow and ice starts at its very base and covers it throughout except where buttresses of bare rock and pinnacles of perpendicular stone jut through the frozen mass, because they are too steep for the snow and ice to rest upon. . . . If we look at a map of Alaska we will see that fully a third of it is above the Arctic Circle, and the climate and other characteristics of this part are truly Arctic. The thermometer falls so low in winter-time that even the short, squatty Eskimo does not have to crane his neck to read the scale; the ground is frozen for numberless feet below the surface, while nothing grows on that surface except the hardy polar mosses that form the marshy covering for the vast tundra for which the Arctic flatlands are so well known. This marshy condition is produced every summer by the deeply-frozen ground thawing but a foot or two under the never-setting sun of that season, the deeper strata of ice remaining to act as an impervious shield to prevent the water from draining through, and on the prairies it remains as ice-water, surrounding the hardy mosses that thrive in it, and into which a traveler will sink up to his knees in the worst parts. A few stunted willows grow along the sluggish streams, but otherwise everything is bare of all except the moss. On this moss graze many herds of reindeer that roam with the wind and migrate backward and forward with the seasons." These reindeer furnish the Eskimos of the north and the Indians of the Yukon River with their meat and warm clothing.

Iridescent Clouds.—Mr. J. C. McConnel has studied the phenomena of iridescent clouds at Saint Moritz, Switzerland, where they are very common in winter, occurring usually whenever there are scattered clouds near the sun. Within a circle of about 2° radius, he says, the clouds are white, faintly tinged with blue. This space is surrounded by a ring of yellow or orange. The region of most vivid hues is comprised between 3° and 7°, and the most striking tints are purple, orange, green, and red. These colors are not arranged in rings, but are distributed over the thinner parts of a cloud in irregular patches. Beyond this region the only colors visible are green and red, which become fainter as the distance from the sun is increased. The author has detected them in a few cases at a distance of 21°. At some distance from the sun the greens and reds are frequently arranged in bands parallel to the edge of the cloud. The author supposes these colors to be the result of diffraction of light by fine particles of ice. The particular color assumed by any part of the cloud is determined by the distance from the sun and the average size of the particles. The particles are supposed to be in the form of thin hexagonal prisms, that being the shape among the known forms of ice-crystals best adapted to produce diffraction. Mr. McConnel calculated the probable diameter of the filaments, and found it to be between ·017 and ·009 millimetre for the purple, ·021 to ·010 millimetre for the orange, and ·014 to ·009 millimetre for the blue. The absence of the colors from clouds composed of water-particles is accounted for by the want of uniformity of size in the water-drops.

Accumulations of Atmospheric Dust.—Ruins of ancient cities and buildings are nearly always found wholly or partly buried. The material with which they are covered has been supposed to originate in the *débris* of buildings that have been erected and human works that have been going on upon their sites, but this can not always, or seldom wholly, be the case; for the same fact appears in desert and wilderness sites. Much is possibly due to superficial disintegration and the work of vegetation; but still another factor, more effective than has heretofore been supposed, may be sought in the deposition of atmospheric dust. In a note on this subject, read by him before the Geographical Society of Paris, M. Violet d'Aouest referred to Richthofen's account of a vast aërial formation of loess in China, and described his own observations in Mexico, where he found on the flanks of the highest mountains argillaceous strata not deposited by waters nor by the decomposition of the rocks; but investigation showed that they were produced by dust raised by the winds from the plains and deposited on the hills. These deposits varied from one hundred feet to—in some places—more than three hundred feet in thickness. They grow finer and finer as the height increases, and cease at the limit of vegetation.

Results of Nerve-Shock.—Many persons who experienced the earthquake in the Riviera have since suffered seriously from nervous shock, although they did not at the time appear to be greatly disturbed. This indicates that more injury may be done to the nerves by an undue excitement than is perceived at the time. The nerve-centers may, as an English medical journal suggests, be likened to batteries, and regarded as apt to be discharged suddenly and sometimes unconsciously; and when once their residual stock of energy is consumed, it can be restored only after a long time and by the exercise of extreme care. It is practically observable that when nutrition is impaired in a nerve-center or branch, extreme difficulty is met in restoring the integrity of the nervous function, and even the wear and tear of ordinary life seems to increase the exhaustion instead of reducing it by stimulation of the recuperative faculty.

Handiwork - Teaching in Swedish Schools.—Slöjd is the Swedish name for handiwork instruction in the schools. It was invented by the famous Finnish educator Uno Cygnæus, and was adopted in Sweden about fifteen years ago. The teaching is confined to simple work in woods, if it is regarded merely as a training for the faculties, or in many branches if it is to be regarded as subsidiary to technical instruction. No efforts are spared to make the system attractive to pupils and parents. Pupils are allowed to keep what they have made, or to buy it cheaply; or are credited with deferred pay, which they forfeit if they leave before a stipulated course is completed, or which is given them as credits in a bank-book on finishing the course. The sympathy of parents is catered to by teaching the children to make and use such common implements as are most in demand at home; and by allowing them the use of the school-tools to make family repairs. The system has proved very successful in Sweden, Norway, and Finland.

Protection of Building - Stone.—All methods of protecting building-stone against decay depend upon filling the pores of the stone with some substance that shall exclude water, the vehicle by which acids are introduced. This is easily done while the builders are handling the stone, but it is very hard after the structure has been set up to paint on the water-proof material so as to insure its absorption to any considerable depth. Several processes including the use of silicate solutions have been described by Mr. W. G. Dent as having been used with more or less of success. Oxalate of alumina applied to limestones gives them a coating of the insoluble double oxalate. Organic substances like linseed-oil give considerable protection for a time, but are ultimately oxidized. Among inorganic or mineral substances paraffine has been used, as upon the obelisk in Central Park, with a degree of success; but the objection holds against its application that the stone has to be warmed to secure a sufficient depth of absorption. The obelisk on the Thames Embankment, London, has been treated with a preparation of solution of gum-resins in petroleum-spirit. But, Mr. Dent says, "if care be taken in the selection of the stone, it is only under special and exceptional circumstances that it will be considered desirable to resort to methods of preservation which must necessarily be expensive, and can only be regarded as the best cure for defects that admit of no other remedy."

The Wild Cattle of New Zealand.—The New Zealand farmers lost great numbers of cattle during the Maori wars which ended in 1868, through their being turned loose by the enemy and by other accidents incident to a season of disorder. These animals and their descendants now roam wild in the bush, particularly on the North Island, where they afford a sport "that is little less exciting and dangerous than that which exists in South Africa and the Western prairies of America." They are exceedingly difficult to reach, on account of the character of the bush around which they hover, which is composed of the long, twining creeper known as "supple-jack." No horse will try to penetrate this bush, because the instinct of the animal tells him that he will get his feet and legs entangled in the vines. "Not so, however, the wild cattle; they will, when surprised, rush madly into the densest shrubbery, and seem fully aware that nothing can possibly follow them into it; and it is thus that instinct has induced these cattle to bid defiance to man, and to live their primitive life over again."

Various Kinds of Soap.—According to a lecture by Dr. Stevenson Macadam, the remains of a well-organized soap-factory have been found in the ruins of Pompeii. Soap-factories existed in Italy and Spain in the eighth and in France in the ninth centuries. The manufacture in Great Britain is first heard of in the fourteenth century. White soap is generally prepared from tallow, with a little lard and palm-oil. In yellow soap resin is added. Soft soap is prepared from fatty substances, with potash. Cocoanut-oil soap has the advantage of being usable with sea-water, and is often called marine soap. Carbolic-acid soap contains about two per cent of carbolic acid, and has antiseptic as well as washing properties. In toilet soaps, as in old brown Windsor, when they are kept for a long time, the soda is influenced by the air and has its strong properties neutralized. Then it is remelted and stored up again, and remelted a second time, when it becomes soft and tender; but the toilet soaps of the present are not always given time to age. Pears's soap is ordinary soap of good quality, cut into shavings, dried, and treated with alcohol. The alcohol evaporates and leaves the transparent soap. The treatment has the effect of taking all the free soda out of the mixture.

Genesis of "Original" Rocks.—Dr. T. Sterry Hunt gave, in the British Association, a concise account of his theory of the genesis of the various groups of original or non-elastic rocks, which he classifies on the basis of their geognostic relations as indigenous, exogenous, and exotic masses. The superficial portion of a cooling globe, consolidating from the center from a condition of igneous fusion, he conceived to have been the protoplasmic mineral matter, which, as transformed by the agencies of air, water, and internal heat, presented a history of mineralogical evolution as regular, as constant, and as definite in its results as that seen in the organic kingdoms. The author next considered the conditions of softening and displacement of indigenous rocks, which permitted them to assume in many cases the relations of exotic rocks, and to become extended after the manner of lavas, as seen in the case of trachytes and many granite-like rocks. Such masses he designated pseudo-plutonic.

Efficiency of Explosives.—It is pointed out by Professor Charles E. Munroe, in his "Notes on the Literature of Explosives," that the theoretical efficiency of an explosive "can not be realized in useful work for several reasons, viz.: because of incomplete explosion; because of the compression and chemical changes induced in the surrounding mineral; because of the energy expended in cracking and heating rock which is not displaced; and because of the escape of considerable quantities of the gases through the blast-hole and the fissures made by the explosion. In all probability the extent of these losses can never be determined by direct experiment, as the phenomenon of an explosion does not admit of a close observation; nor can it be determined by comparison with the work done under other circumstances, as we are as yet uncertain as to the so-called dynamic resistance of rock. The useful work of a blasting charge is employed partly in shattering the rock and partly in throwing or displacing the shattered masses. It is a familiar engineering problem to reduce the projectile force of a blast to a minimum by means of suitable-sized charges, properly located in blast-holes of estimated dimensions, and so avoid the cannonading of which workmen are fond. With the discovery of at least approximately correct values for the useful work of charges, we are now able to demonstrate the correctness of this principle."

Mistakes in treating Organic Refuse.—Most of the shortcomings of modern sanitary methods, says Dr. G. V. Poore, are due to the fact that, in our dealing with organic refuse, we commit a scientific error—i. e., we pursue a course that is in opposition to natural law. This error consists in mixing organic refuse with water. It then undergoes changes which differ widely from the changes which it undergoes when mixed with earth. According to Wollny, the process of oxidation of organic matter and the formation of nitrates take place most readily when a moderate amount of moisture is present, and the most favorable amount is about thirty-three per cent. When water is in excess, the amount of free oxygen is insufficient to favor the growth of mold-fungi, the schizomycetes (bacteria and micrococci) are formed, and, in place of oxidation, putrefaction occurs, with the formation of ammonia, free nitrogen, carbonic acid, and carbureted hydrogen. This process of deoxidation takes place in mixtures of putrescible matter with water, and takes place also, it is said, in soil which is thoroughly soaked in sewage. In the face of these facts, it is not to be wondered at that "sewage farming" has not proved a commercial success. We must, indeed, be in doubt whether, when the circumstances are more than usually unfavorable, it exercises any very great purifying action upon the putrescible mixture. In the treatment of putrescible refuse we have to aim at nitrification rather than putrefaction, and it is certain that by mixing with water putrefaction is encouraged and nitrification delayed. It seems to be almost incontestable that the proper course to pursue with regard to organic refuse—putrescible matter—is the very reverse of what we do pursue. We clearly ought to encourage oxidation and make putrefaction impossible. Putrefaction is certainly a great cause of ill-health. The putrefaction of organic refuse when mixed with water has, Dr. Poore thinks, been the chief cause of the development of modern sanitary progress—that is, of the need of doing something. Our forefathers were not given to this method of treating putrescible matter. House-slops trickled along open gutters, and excremental matters were deposited in dry pits.

Cameo-cutting for Amateurs.—Mrs. Henry Mackarness, in her "Young Lady's Book," represented cameo-cutting as an art simple enough to be acquired without great difficulty, which would "give young ladies a new and elegant pursuit." Only two kinds of tools are used, which are named the scawper and the spit-sticker. The work is performed at a bench or table, furnished with suitable gripping apparatus, the shell being fixed with setter's cement on a stick, which may be made of a five-inch section of a broom handle. Care should be taken to select a piece of shell without a flaw. Beginners should choose tolerably smooth pieces; but practiced workers prefer those which are irregular in their surface, because they furnish more scope for the exercise of skill. In cutting these the design follows the convolution of the shell. Care must be taken in cutting not to let the ground show through; but a skillful cutter will so arrange his design as to produce the blush of the ground in such portions as to enhance the value of his work. Shells are further liable to the faults of displaying crooked lines in the cutting, which are believed to have been the work of worms in the earlier stages of their development, and of "flaking." Beginners will draw the figure before attempting to cut; but a skillful operator will cut away at once, and rough out the head and face of a portrait very quickly. A workman can cut a portrait from a photograph in a few hours. The beginner should not spend more than two hours at a single sitting. In beginning, the learner should cut a few simple outlines, such as are furnished by the rose, the lily, or the fuchsia; the hand soon becomes accustomed to the use of the tools, and the timid cut becomes exchanged for the vigorous and graceful stroke of the artist. Great care is necessary in working the shell so as not to cut into the ground, on account of the extreme difficulty of removing any marks. Marks are removed by the use of powdered pumice-stone and water, applied on a piece of pointed wood; the next process is to smooth the surface with pumice-stone and oil; wash with a soft brush and warm water, then polish with the dust of the rotten-stone and sulphuric acid, mixed to a paste, and applied on the point of a piece of wood.

Vaccination and Erysipelas.—A report by Dr. Airy, on three cases of so-called fatal erysipelas after vaccination, will help in forming a judgment of the sort of foundation on which the fears of an outcome of this character rest. The three children were vaccinated by three different practitioners. In the first case the erysipelas set in too late for it to be possible for vaccination to have had anything to do with causing it; in the second case the child was surrounded with erysipelas in the surgery where it was brought to be vaccinated; in the third case no definite source of erysipelatic infection could be discovered, but the child lived in a low-lying place, close to swampy and unhealthy meadows. Thus, none of the cases were traceable to the vaccine lymph; and its innocence is attested by the fact that other children were vaccinated with the same lymph without the occurrence of untoward symptoms. The question arises next as to the degree of danger of erysipelas entering the vaccination-scratch, or the wound left by a ruptured vesicle, the same as it might any other wound. According to statistics presented by Dr. Buchanan, the proportion of such accidents that occurred in England and Wales during 1883 was 51 infants dying of septic disease out of 763,192 vaccinated.

Lime-Salts in the Food and the Teeth.—Dr. W. D. Miller, of Berlin, has been making experiments to determine how far changes can be produced in teeth by the presence or absence of lime-salts in food. His method is to extract a tooth from a healthy dog, and then to feed the animal upon food containing but little lime-salts for three months; then to remove a second tooth, and change the food to one containing an excess of salts. After four months of this treatment another tooth is extracted. The author has found that an appreciable loss of lime-salts occurs in the first stage, which amounts in one case to more than one per cent, and that the proportion of lime-salts rises again to normal during the second stage.

The Making of Britain.—In studying, by geological evidences, the changes which have taken place in Great Britain since it was first inhabited by man, Professor Archibald Geikie goes back to the time when it was not yet an island, but formed a part of the European Continent. Its separation occurred by gradual subsidence, in which the chalk ridge between Dover and Calais was the last landmark to disappear; and "along this narrow ridge the earliest Celtic immigrants may have made their way." It was probably finally washed away as much as sunk. At the dawn of history, the general appearance of the country must have been characterized by wide-spread forests, abundant bogs and fens, and a profusion of lakes; and at the first coming of the Romans the greater part of the country was probably covered with wood. Large tracts of these woods persisted for many hundred years, and as late as the twelfth century the woods to the north of London swarmed with wild boars and wild oxen, and the woods everywhere were the resorts of broken and desperate men. In the course of generations the wood and open land have largely changed places. The belts of clay soil, originally the most heavily timbered tracts, proved admirably adapted to agricultural purposes and were cleared for cultivation, while the open places, with their light soils, were abandoned, to become wastes of scrub and copsewood. Great topographical changes have been wrought by the disappearance of the fens and bogs. Some have been naturally silted up, and others have been artificially drained; while their sites are still indicated by such Saxon names as Bogside, Bogend, and Mossflats; and by the black, peaty soil which marks where they once lay. No one would be led to suspect by the examination of modern maps the number of lakes that once dotted the north of England and Scotland; but inspection of old maps will show many sheets of water that do not now exist, or are much reduced in size. Topographical names will reveal the sites of other and sometimes still older lakes, while geological evidence will tell of others of which there is no human record. Other changes have been and are going on along the shore, where the land is washed away at some places and added to at others. All these things are subjects for profitable study, and call for it; and we may add that similar changes are going on and invite attention in the United States. Their progress is much more rapid than any one could suppose till he begins to make it the subject of careful observation.

The Ruby-Mines of Burmah.—The ruby-mine tract in Burmah, according to Mr. G. Skelton Streeter's description in the British Association, is a large valley some twelve miles long by eight miles broad, and composed of several small valleys, or rather basins. It lies on the slope of the Sibwee Doung, which divides the Irrawaddy and Salwen Rivers. The valley bears signs of volcanic origin. The mines are of three distinct kinds. The first is furnished by the metamorphic rock, whose mass is traversed in all directions by huge fissures, caused probably in the past by shrinkage. These fissures are filled with a soft, clayey earth, generally containing rubies. At present they are worked in a very superficial manner. The mines of the second variety are on the sides of these rocky hills, where diversified strata of clayey consistency have been upheaved. The natives wash this earth slowly away by hydraulic mining. The third system of mining is by sinking pits in the lower or plain parts of the valley, and washing the earth extracted by hand.

Effects of an Earthquake.—A paper was read in the British Association by Dr. T. Sterry Hunt and Mr. J. Douglas, describing their observations of the effects of an earthquake which took place in Sonora, Mexico, on May 3, 1887. The authors found the results of the undulatory movements of the soil apparent in the San Pedro and Sulphur Spring Valleys in great numbers of cracks and dislocations. For distances of several hundred feet, sometimes with a generally north and south course, vertical down-throws on one side of from one foot to two feet were seen, the depressed portion rising either gradually or by a vertical step to the original level. Branching, and in some cases intersecting, cracks were observed. These depressions were evidently connected with outbursts of sand and water, which, along cracks—marked by depressions on both sides—sometimes covered areas of many hundred square feet with layers a foot or more in depth, marked here and there by craters, two feet in diameter, through which water had risen during the outburst of these volcanoes.

Agassiz's Service to Evolution.—Professor Le Conte's ascription to Professor Agassiz of the credit of having laid the basis for the doctrine of evolution is confirmed, from a different point of view, by Professor Alfred Newton, in his opening address before the Section of Biology of the British Association. The speaker, referring to Agassiz's doctrine of centers of creation, said that "creation in his mind was no figurative expression. He meant by it . . . a direct act of God—in other words, his belief was, that there had been going on around us a series of mysterious performances, not one of which had ever been consciously witnessed by a human eye, each of which had for its object the independent formation of a new living being, animal or plant." This doctrine of a continuous series of miraculous acts having gone on for an indefinite time was perfectly logical when the premises were admitted; and it became obvious that the alternative was between that doctrine and the theory of transmutation of species. The having made this thought clear is declared by Professor Newton to have been a great service rendered to the new theory by one who was its most determined opponent.

A Floral Moth-Trap.—Mr. Robert E. C. Stearns, in the "American Naturalist," describes the plant *Araujia albens* as a "moth-trap." The plant, formerly called *Physianthus*, is a native of Buenos Ayres, but has been pretty widely distributed in the United States, and may be found now at places as far apart as Boston and San Francisco. The insects are caught in the flower, which is trumpet-shaped, flaring at the mouth, where the petals divide, and then uniting and forming a tube, which is swollen into a bulbous form where the corolla joins the calyx. The stamens are furnished with side wing-like processes and exterior spurs, which press against the gymnecium, and hide the ovaries and pollen-masses. "The moth, in pursuit of the nectar, first reaches that portion contained in the pockets between the bases of the spurs; then, in search of more, having already thrust the proboscis down the tube of the flower, describing a curve between the exterior of the stamineal crown or mass and the inside of the bulb of the perigonium, it has to push the proboscis upward in order to reach that portion of the flower where the anther-cells, pollen-masses, and glands are in close juxtaposition." Having satisfied its hunger, or otherwise, upon attempting to withdraw the proboscis by a direct pull—which it can not do, because the organ is not provided with any muscular arrangement by which the curved motion made in entering can be reversed—the proboscis "becomes wedged in between the edges of what may be termed the anther-wings, or rather the edges thereof, and is held tight, very much in the same way that an old-fashioned boot-jack grips a boot. The more the moth pulls, the tighter or firmer the grip, and escape is impossible, unless the flower has reached such a degree of maturity that its substance has become somewhat softened or wilted."

Disinfection by Heat and by Steam.—Dr. H. F. Parsons has found, in experiments on the disinfection of packages by heat and by steam, that dry heat at the boiling-point for an hour is sufficient to destroy active bacilli of all ordinary infectious diseases; but, if spores are to be attacked, a heat of 245° for an hour or of 220° for four hours will be required. The complete penetration of an object by steam-heat for more than five minutes is sufficient for its full disinfection; and this method is applicable to such articles as pillows, which are very difficult of penetration to dry heat. Moistening the air of the heated chamber diminishes the time necessary for penetration, while it also makes the distribution of temperature through the chamber more agreeable, and tends to prevent the scorching of articles placed in it; but it was not found to increase the disinfecting power at the temperature employed. Damage may be done to articles in disinfecting them by heat or steam, by scorching or partial decomposition of organic substances; by fixing of stains; by melting of fusible substances; by changes in color, gloss, etc.; by shrinking and felting of woolen materials; or by wetting. The nature of the articles should, therefore, be regarded in adapting the process to them.

English Taxes.—The first recorded tax imposed upon Britain was laid by Julius Cæsar, who, after his victories, required for Rome an annual tribute of men and wild animals—the men to be kept as hostages, the animals to be fought with in the arena. When ecclesiastical domination came in, the Pope levied a "Peter's pence" for the support of his English University at Rome. When the English conquered Wales, they levied on the people an annual tax of three hundred wolves' heads, which proved a great blessing to the principality. After England became exposed to great danger from the incursions of the Northmen, a land-tax of twelve pence per "hide" was levied in order to raise a sum with which to buy off the invaders. The consequence of this silly policy was that more invaders came to be bought off. A poll-tax was imposed in the fifteenth century of one shilling a year upon every person, except he belonged to the clergy, above the age of fifteen years. This was distasteful to the people, and led to rebellion. In another form of taxation, laborers and tradesmen were required to give their services to the king or to a noble. Many palaces, Windsor Castle among them, were built in this way. From 1695, for thirteen years, every person not a pauper was required to pay a tax for each child born to him, rising from two shillings in the case of a common person to thirty pounds in the case of a duke. A bachelor's tax of one shilling in the case of ordinary persons was imposed on unmarried men over twenty-five years old, and on widowers without children, but wealthy people and nobles had to pay more. By Queen Elizabeth's act of uniformity, persons who refused to become Episcopalians, or who absented themselves from church on Sundays, had to pay a tax of a shilling a year. Perhaps the most oppressive and impolitic taxes imposed by the British Government were those on windows and on funerals, with which even the history of this nineteenth century has been blotted.

NOTES.

The second ten days of January were extraordinarily cold all through the Northwest, and temperatures were registered at some places much below what had ever before been observed in the United States. At Iowa City, according to Professor Hinrichs, the mercury was at or below zero every night from the 11th to the 20th. During the twenty-eight years that weather observations have been taken, there have been only five decades having a mean temperature of zero or below; only one of these was during the first eighteen years, while the other four were during the last ten years. This shows that extreme cold has been seven times more frequent during the latter than during the former years, and is another indication of what the author has often held, that the later winters in Iowa have been colder than the former ones.

A "cable anchor" has been successfully tried in the Seine for stopping boats. The apparatus is a cable, having on it a series of canvas cones, which open out by the action of the water, and close again when drawn the usual way. A steamer running thirteen knots was stopped each time by the apparatus in thirteen seconds, and in a space of from twenty to thirty feet.

Professor Mushketoff describes the effects of the operations of the marmots in modifying the surface of the Siberian steppes as important. Their heaps of earth cover hundreds of square miles, and each one of them represents at least two cubic metres of earth removed, or about 30,000 cubic metres brought to the surface on each square kilometre.

The survey and last census of India show that the area of the peninsula of Hindostan is 1,382,624 square miles, and the population 253,891,821. Although immense tracts of country are annually cultivated, ten million acres of land suitable for cultivation have not as yet been plowed; and one hundred and twenty million acres are returned as waste lands.

M. Jovis, Director of the Aëronautic Union of France, has found a satisfactory varnish for textile materials. It is described as being of great flexibility, as containing no oleaginous base, and, while adding little to the weight, as conferring great impermeability. It is well adapted for balloons, marine cordage, sails, tents, and similar structures; is suitable for paintings and wainscotings; is exempt from moldiness; can be exposed to very varied temperatures without alteration; and furnishes sub-products which can be utilized for coating walls, railway-sleepers, etc.

Professor W. Mattieu Williams offers as a better explanation than the old one of the zigzag course of lightning, that owing to variations of moisture the conducting power of different portions of air is variable, and the electric discharge follows the course of least resistance.

Experience at the Winter Palace of the Czar at St. Petersburg indicates that the electric light injures the exotic plants used for the decoration of the rooms by causing the leaves to turn yellow, dry up, and fall off. The experiments of Dr. Siemens led him to a different conclusion, but his greenhouse was heated by the waste steam from the engine driving his dynamo, and this perhaps was of beneficial effect sufficient to counteract the mischief done by the light.

An effective composition for a "hand-grenade" fire-extinguisher is, common salt, 19·46; sal ammoniac, 8·88; water, 71·66; or 20 pounds of salt, 10 pounds of sal ammoniac, and 7 gallons of water. The flask should be of thin glass, so that when thrown with force against any object, it will fall to pieces. The grenades, costing but little, can be distributed freely all over the premises to be protected; and, should a fire occur, break a bottle or several bottles over it, and the disaster will probably be averted.

M. Bonnal has observed, by experiment, that hot baths induce a loss of weight caused by the sweating, which lasts for about twenty-four hours. It is compensated for by increased drinking and diminished urinary secretion. Baths of dry hot air provoke a sweat that ceases on coming out of the bath, while the perspiration provoked by warm-water baths and warm moist-air baths lasts frequently for an hour after the bath is over. The nervous incidents of the bath, such as the acceleration of the pulse and of respiration, make their appearance before the central temperature exhibits any elevation.

J. Chalmers Robertson, M. B., relates in "The Lancet" the case of a family whom he had attended, who were poisoned from eating bread in which mold had developed itself. Every member who had partaken of the loaf in ordinary quantity had been made ill; one member who had merely eaten a small piece, felt uncomfortable; those who did not eat any remained well. The symptoms were diarrhœa and pain in the epigastrium. The author suggests from this experience, that it is possible that we may have in undetected diseased bread an important factor in the causation of diarrhœa which we would not readily suspect.

Persons whose plants mysteriously sicken and die out, may learn from the experience of Dr. J. W. L. Thudicum, as related by him to the London Society of Arts. He watered a frame of flourishing young wall-flowers, the ordinary tap being dry, with water of at least suspicious purity from another tap. The plants were soon infected with a fungus, and in a short time the frame did not contain a healthy, hardly a living plant. For two summers the mignonettes in a conservatory were destroyed by a root-fungus which distorted the plants and made them sickly and short-lived. The only way in which this parasite could be got rid of was by destroying the earth and all wooden boxes by fire, and growing no mignonette in the conservatory for two years.

Mr. Maignen made last year a successful and satisfactory exhibition of his process for softening water by means of the material called "anti-calcaire." Steam-boilers which had already become slightly incrusted with lime, were worked for two years with water softened by anti-calcaire without attention. When opened, they were wholly free from incrustation, showing that the material had not only prevented the effect taking place, but had also destroyed what incrustations had already accrued.

A collection of specimens of poisonous fishes is shown in connection with the exhibition recently opened in Havre, France.

Some are poisonous when eaten; others are merely venomous. Among the first are many spheroids, a tetrodon, and many *Clupea*, which are abundant near the Cape of Good Hope. In the Japan Sea is found a very peculiar tetrodon, which is sometimes used as a means of suicide. It brings on sensations like those produced by morphia, and then death.

The nervous irritation produced by tinnitus, or noises in the ear, from which many persons suffer much, has been mentioned as a possible cause of mental disorder. The coarser diseases of the ear are subject to surgical treatment from without; but nervous affections provoked by obscure disorders are not so amenable, because their causes are more subtle, although none the less real. Sometimes an obstruction of the eustachian tube may be the chief cause of tinnitus.

OBITUARY NOTES.

Dr. Asa Gray, the eminent botanist, died at his home in Cambridge, Massachusetts, January 30th, in the seventy-eighth year of his age, after an illness of about a month. He was born in Paris, Oneida County, New York, in 1810; studied medicine, and received the degree of M. D. in 1831, but never engaged in practice; became an assistant in the chemical laboratory of Dr. John Torrey in 1833; and a little later was appointed curator in the Lyceum of Natural History. His first botanical writings were descriptions of sedges and of certain plants of northern and western New York. In the "Elements of Botany," published in 1836, he showed that he had already views of his own, which he was not afraid to utter, even though they might be different from those of the then recognized authorities in science. From that time till the end of his life he worked with unceasing activity and growing fame, and for many years he has been recognized as one of the leading botanists of the world. His numerous works are well known to all readers and students, and can not be catalogued in a note. It is enough to say of them that whichever class of them we regard, they have never been excelled.

Professor T. S. Humpidge, chemist of the University College of Wales at Aberystwith, died November 30th, aged thirty-four years. He prosecuted his earlier scientific studies while serving as a clerk in a corn-merchant's office, at the evening classes of the Science and Art Department, and afterward studied under Professors Frankland and Bunsen. His first publication was on "The Coal-Gas of the Metropolis." He investigated the atomic weight of beryllium, made redeterminations of the specific heats of various metals, and translated and edited Kolbe's "Inorganic Chemistry."

Professor Bonamy Price, Professor of Political Economy in the University of Oxford, died in London, January 8th. He was born in Guernsey in 1807; was one of the masters in Dr. Arnold's school at Rugby from 1830 to 1850; and was one of the recognized authorities in his special branch of research. His lectures, in their published form, have had an important economic influence. They include "The Principles of Currency" (1869), and "Chapters on Political Economy" (1878). In 1876 Professor Price published another work, "On Currency and Banking."

Dr. Carl Passavant, the African traveler, died recently at Honolulu, in the thirty-fourth year of his age.

Dr. Ferdinand Vandeveer Hayden, a geologist whose name is inseparably associated with the Government explorations of the Rocky Mountain region, died in Philadelphia, December 22d, after an illness of many months. He was born in Westfield, Massachusetts, in 1829, and was graduated from Oberlin College in 1850, and from the Albany Medical College in 1853. He was connected for more than twenty years, a great part of the time as chief, with the explorations of the Western Territories, including Kansas, Nebraska, Colorado, New Mexico, Dakota, Montana, Idaho, and Utah. Besides the official reports of his exploring work, he was the author of the books, "The Great West; its Attractions and Resources" (1880), and "North America" (1883). He was a member of most of the American scientific societies, and an honorary and corresponding member of many foreign societies.

M. F. J. Raynaud, an eminent French electrician and director of the Higher School of Telegraphy, died early in January, from the results of a murderous attack. He was associated with the laying of several telegraphic cables, one of which, crossing the Seine, having been broken, he repaired in 1870, in the face of the enemy's fire. He was the first person to call the attention of French men of science to the labors of Englishmen in electric unities; and he translated Gordon's "Treatise on Physics" into French.

The recent death is announced of Professor Arthur Christiani, of the Physiological Institute of Berlin, who was a great authority on the physiological action of electricity, and on the physiology of the nervous system and of the sense of hearing.

Dr. Max Schuster, an eminent petrologist, of the University of Vienna, died last November.

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COLLEGE ATHLETICS AND PHYSICAL DEVELOPMENT.

By Professor EUGENE L. RICHARDS,
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IN an article on "The Physical Proportions of the Typical Man,"* Dr. Sargent has taken occasion to speak of athletics in connection with the general subject of physical development. In the following pages I wish to show that neither in that article nor in the subsequent article, on the "Physical Characteristics of Distinguished Athletes," † did he do justice to the influence of athletics in "reminding the individual of the ultimate aim of every kind of physical exercise"; that his remarks on the loss resulting to athletics from "making excellence in achievement the primary object" of them would have had more force if they had been more discriminating; and, finally, to present some statistics which lead to conclusions favorable to athletics.

"Every writer on education, from Plato to Herbert Spencer, has advocated physical activity as a means of attaining that full-orbed and harmonious development of all parts of the human economy so essential to robust, vigorous health." Theorists, then, are agreed upon this as the "ultimate aim of every kind of physical exercise." But we all know how difficult it is to get the best theories put into practice. They may commend themselves as the very best, but they fall far short of their good to men till they can be made working theories. In this respect the "harmonious-development" theory, whether mental or physical, forms no exception to other theories. But once get hold of some motive by which to induce even a few individuals to put a theory into practice, and half the battle is won. If it is a really good theory, its own practical examples prove the fact. "Wisdom is justified of her

* "Scribner's Monthly," July, 1887. † Ibid., November, 1887.

children." Here is always the difficulty—to get hold of the motives which will influence men and women in such way that they may finally be possessed by the "love of symmetry in form" which has such "a deep moral significance." You may preach the doctrine to children, and your words will be like the idle wind. Even our young men and our maidens will prefer snug-fitting garments and handsome raiment covering a bad form, to the proportions of Apollo or the beauty of the Venus of Milo not clothed in the fashions of the day. Many men and women, staggering along under burdens of ill-health, self-imposed by neglect of the simplest natural laws, will give your beautiful theory small thought. They will pursue their phantoms of wealth and ambition, while they hug the delusion that they suffer by God's will in this "vale of tears." They do suffer, and deservedly, but only because they do not use their own wills to conform their conduct to His good-will as revealed in the constitution of their own being. It is useless to set forth to such people the truths of health, the glad tidings of deliverance from many of their ailments by the natural remedies of air, exercise, and food. The doctrines of health have always been preached, and men have not heeded. Let us begin, then, with children, and *educate* them to these high truths. But with children we have to use authority or play upon motives. If we use authority merely, the idea of harmonious development will become distasteful to them. They will break away from authority and break with the theory at the first opportunity of liberty. Put them at what we elders call play, and they often accomplish of their own free-will what we with difficulty get out of them by force. Now I say that, by their various athletic organizations, young men are doing this very thing for themselves that children do in play. They establish in the colleges a system of training for their various sports which affects not only the members of the higher institutions of learning, but which reaches almost every young man in the land. To express the idea in Dr. Sargent's words, "the college clubs look to the academies, the academies to the schools, the schools to the homes and firesides, to furnish candidates for athletic honors." Dr. Sargent proposes this as one of his objections to making "excellence in achievement the primary object of athletic exercise." But it is the reward which this same "excellence in achievement" receives that brings forward good material and stimulates an increasing number of men to exercise, who would never think of doing so without this stimulus. One is at a loss to understand how this fact should account (as Dr. Sargent says it does account) for the "lack of active interest in athletics." On the contrary, it is one of the principal causes of that active interest; it keeps young men in training, holds them to regular, systematic exercise, in season and out of season, through an important and critical period of their growth; it sends them into the gymnasium when the season forbids practice in the field; it restrains them from excesses, from smoking and drinking, and from late hours;

it brings the whole force of college opinion to bear in favor of a healthy, moral life. To be sure, the desire to defeat a rival club or team is not the highest motive of the human mind ; the honor of winning a medal in a race is not the greatest honor which earth can afford. The glory of being champions at any game seems puerile to serious-minded people ; but we must take young people as we find them. If we can not induce them to exercise by the "deep moral significance" of "the beauty of symmetry of form," we must lay hold of the motives, not wrong, which do influence them. The majority of them not being open to the highest motives, we take the next best motives which appeal to them. That is the principle on which all education is conducted. Competitions, prizes, medals, honors, appeal to students, move them, and hold them to efforts which higher and worthier objects fail to call forth. By these we educate them to habits which fit them to receive the higher motives. They are their schoolmasters to train them for a better life. So it is in athletic sports. By habits of exercise from earliest youth young men are educated to appreciate the value of it. Accustomed to feel the good effects of it in themselves, or to see the good of it in the person of some upholder of the honor of their club, they learn to admire the cause of this good. The prominent athletes present examples of beauty of form and vigorous health. The sight of them stimulates many a man to try on his own person the effect of the training which he sees embodied in the winners of prizes or championships. More than this, having once learned the value of exercise to health, he forever associates together health and exercise in a necessary companionship. So the athletes preach to all men by example.

We will now consider the various athletic sports, in order that we may weigh the justice of Dr. Sargent's remarks on the evils of making "excellence in achievement" their "primary object." We may eliminate from the sports certain ones not liable to these evils, such as have for their object a victory, not a prize. To the contestants the importance of match-games of foot-ball, base-ball, lacrosse, and polo lies not in excellence of achievement, but in defeating rival organizations. The big score may be desirable, but the principal aim is the championship. Rowing, also, may be said to be free from these evils, because, though "good form" and the best stroke may be aimed at, the principal purpose is to put the boat over the course fast enough to come in first at the finish. Excellence in achievement consists in winning the race. Fast time may be acceptable, but, if the winning boat makes the fastest time for its particular race, the winning crew is satisfied.

If, therefore, we remove base-ball, foot-ball, and rowing from the list of athletic exercises which are liable to the evils following from "making excellence in achievement" "the primary object" of them, Dr. Sargent's seven specifications can not apply to them. Some of them may apply on other grounds, but not as corollaries of "excellence of achievement." Some of them do not apply at all; viz., robbing them of half their value—III. "*By reducing the number of active competitors*"; IV. "*By relying upon natural resources rather than upon cultivated material*"; V. "*By depriving the non-athletic class of every incentive to physical exertion.*"

"III" is disproved by the fact (only necessary to be mentioned in order to be admitted) that the number of active competitors has increased so much, especially in the colleges, that instead of contests between a few clubs in one large association, the contests are now between many clubs in many associations.

"IV" has already been noticed, but the question might be raised whether it were possible to look for material from any other than "natural resources." If it were, does not "IV" conflict with "II," in which "making excellence in achievement the primary object of athletics" is said to "rob them of half their value" "*by increasing the time devoted to practice*"?

"V" is not true, as the non-athletic class is continually being stimulated to exercise by the example of the athletic class, a fact on which I have already commented.

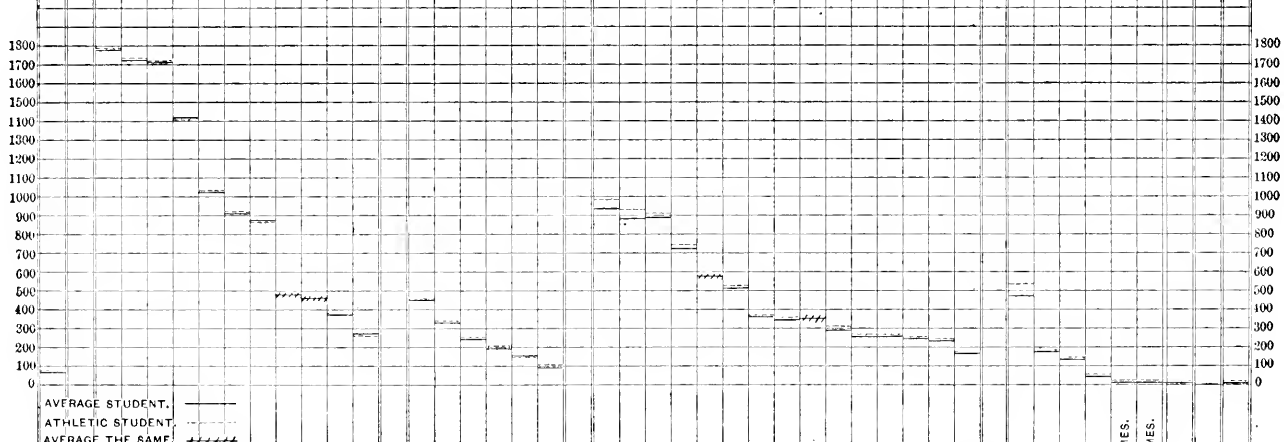
The objections of expense and time I have considered elsewhere,* but will assert here that, in these respects, athletics merely keep pace with other undertakings of modern times. More money is spent upon education than formerly. More money goes to gymnasiums. There is more money in the land. Success as well as failure costs more. But we are getting better results. We are inducing more people to exercise. The increased cost is due to the better results. Like every other good, exercise costs something. The real question is, whether the results are worth the cost. I think they are. I maintain that the saving to the health and morals of our young men all over the land is worth the whole cost of their athletic organizations.

As to time, it is undoubtedly true that some young men spend too much time in athletic exercises, but the majority of them do not do so. They spend no more time than is good for them, at a period of their lives when they are laying up physical capital. And the fact that, to be well prepared for contests, successful athletes have to keep in training the greater portion of the year, instead of during a small part of it, as formerly, is one of the best features of the present system of athletics. It gives them healthy occupation for their leisure moments, and enforces habits of good living all the year, instead of for a few months.

To "VI" I have very little to say, except to express a more hopeful spirit with regard to the future of "all competitive sports which bring men into personal contact." Putting boxing out of the list, it seems to me that young men interested in the other sports are in a

* "Popular Science Monthly," March, 1884.

PHYSICAL MEASUREMENTS AND TESTS OF THE AVERAGE, AND THE ATHLETIC STUDENT IN AMHERST COLLEGE: MARCH, 1887.



Group	Measurement	ATHLETIC.	AVERAGE.	Unit
	WEIGHT.	664	62.1	KILOS.
LENGTHS.	STRETCH OF ARMS.	1707	1793	MILLIMETERS.
LENGTHS.	HORIZONTAL LENGTH.	1741	1737	MILLIMETERS.
LENGTHS.	PERPENDIC. HEIGHT.	1735	1725	MILLIMETERS.
LENGTHS.	STERNUM.	1411	1415	MILLIMETERS.
LENGTHS.	NAVEL.	1032	1030	MILLIMETERS.
LENGTHS.	SITTING.	913	912	MILLIMETERS.
LENGTHS.	PUBES.	866	869	MILLIMETERS.
LENGTHS.	KNEE.	476	476	MILLIMETERS.
LENGTHS.	ELBOW TIP.	462	462	MILLIMETERS.
LENGTHS.	SHOULDER ELBOW.	375	372	MILLIMETERS.
LENGTHS.	FOOT.	261	262	MILLIMETERS.
BREADTHS.	SHOULDERS.	445	434	MILLIMETERS.
BREADTHS.	HIPS	330	329	MILLIMETERS.
BREADTHS.	WAIST.	259	254	MILLIMETERS.
BREADTHS.	NIPPLES.	203	199	MILLIMETERS.
BREADTHS.	HEAD.	153	155	MILLIMETERS.
BREADTHS.	NECK.	110	108	MILLIMETERS.
GIRTHS.	CHEST FULL.	982	935	MILLIMETERS.
GIRTHS.	CHEST REPOSE.	921	887	MILLIMETERS.
GIRTHS.	HIPS.	912	891	MILLIMETERS.
GIRTHS.	BELLY.	750	724	MILLIMETERS.
GIRTHS.	HEAD.	572	572	MILLIMETERS.
GIRTHS.	THIGH.	533	518	MILLIMETERS.
GIRTHS.	KNEE.	366	361	MILLIMETERS.
GIRTHS.	CALF.	356	318	MILLIMETERS.
GIRTHS.	NECK.	353	353	MILLIMETERS.
GIRTHS.	R. U. ARM CONTRACTED.	313	296	MILLIMETERS.
GIRTHS.	FOREARM.	269	262	MILLIMETERS.
GIRTHS.	UPPER ARM.	269	260	MILLIMETERS.
GIRTHS.	ELBOW.	256	251	MILLIMETERS.
GIRTHS.	INSTEP.	247	242	MILLIMETERS.
GIRTHS.	WRIST.	168	164	MILLIMETERS.
TESTS.	TOTAL STRENGTH.	532	464	KILOS.
TESTS.	LEGS.	179	169	KILOS.
TESTS.	BACK.	147	138	KILOS.
TESTS.	FOREARM.	44	38	KILOS.
TESTS.	CHEST PULL.	13	10	NUMBER OF TIMES.
TESTS.	CHEST DIP.	10	6	NUMBER OF TIMES.
TESTS.	LUNGS.	1.6	1.2	KILOS.
	LUNG CAPACITY.	4.65	4.2	LITERS.

fair way to solve for themselves the problems connected with them, so as "to retain the good features and to hold the evil ones in check."

The danger to athletics—" VII. *By depriving them of their efficacy as a means of health*"—is the only specification which might follow as a corollary from making "excellence in achievement" their "primary object." It is a danger, however, to which only a few men are liable in the athletic exercises mentioned by Dr. Sargent. I think, also, that it will be found that athletes in general are beginning to learn that to excellence and success, even in any special kind ofexercise, a uniform muscular development contributes quite as much as the training of a few sets of muscles.

As bearing on this part of the subject, the remarks and chart published by Dr. Edward Hitchcock, of Amherst College, are here given. As Dr. Hitchcock is the Nestor of physical culture in the colleges, his observations have been very extensive, and his conclusions are well worthy of consideration:

"One of the results of the anthropometric work of Amherst College has been THE APPROXIMATE MEASUREMENTS AND TESTS OF THE AVERAGE COLLEGE STUDENT, as obtained from the 1,258 different men observed during the past six college years. These are numerically and graphically arranged on the preceding page.

"The study of the present paper is to show THE RELATION OF THESE STATISTICS TO THE SAME IN THE ATHLETIC STUDENT.

"The men from whom these have been obtained were either class captains, the ball nine, the foot-ball team, or first prizes in the gymnastic exhibition and athletic games. Fifty-seven men in all.

"A study in connection with these, is what physical conditions, if any, specially characterize the athletic man in distinction from the average man or student. The chart on the preceding page shows a very close relation between the *measurements* of these two groups, but a little broader one in *tests of strength and capacity*, the greater one being in favor of the athletic man. The common consent of mankind would probably place in the same category *great size and great strength* of body, but, *in feats of skill*, our *statistics do not confirm this combination* as a fact in nature. So far as Amherst College results are concerned, they seem to show that the athletic men are not athletic because of a greater height of body than the average, as the difference between them in this feature is only a centimetre, or four tenths of an inch. Of the fifteen men who took first athletic prizes in 1886, four were above and eleven below the average height of the college; and, of the nine first-prize men at the gymnastic exhibition, three were above and six below the average height.

"Another grouping of these statistics shows us what items are most alike in the make-up of these men. As already mentioned, the heights are nearly the same. So are the lengths and other measures of the framework, such as sitting height, length of arms and feet, and the breadths, which are determined by the bones as a basis of measurement. Of *eighteen bony measurements*, twelve give no greater difference than a single millimetre, or one hundredth of one per cent between the two. Of eleven of the *soft* or *muscular measures*, including the variable and developmental parts of the body, the range of difference is from five to forty-seven millimetres, or 3·3 per cent differences between the two. And of the tests of *strength and capacity* we find an average of 7·2 per cent in favor of the athletic man.

"Or we may group the items as in the graphic form. Here we find the increase in favor of the athletic student in *weight* is 6·92 per cent; in *lengths*, 0·14 per cent; in *breadths*, 1·42 per cent; in *girths*, 2·56 per cent; and in *tests*, 10·24 per cent.

"The grain of truth derived from these pages seems to be that athletism does not seem to depend so much on physical gifts, accidents, or circumstances, as in the energy of will which is put into the muscles. The long arm and leg and the big muscle do not insure the feat, but the skill in using them. It is the intelligent training, and not the big measures, which determine the standards of excellence in our athletic feats and sports.

"President Garfield said: 'There is no way in which you can get so much out of a man as by training; not in pieces, but the whole of him; and the trained men, other things being equal, are to be the masters of the world.'"

At no college in the land is more careful attention given to physical development by means of gymnastic exercises than at Amherst. If, therefore, Dr. Sargent's statements were true with respect to partial development by athletics, the fact ought to show in these averages, and specially against the athletic student. The contrary fact appears.

Notice Dr. Hitchcock's conclusion, that "athletism does not seem to depend so much on physical gifts, accidents, or circumstances, as in the energy of will which is put into the muscles. . . . It is the intelligent training, and not the big measures, which determine the standard of excellence in our athletic feats and sports." This will-power, guided by intelligence, makes not only successful athletes, but successful men. The training which young men receive in their sports possesses its highest value by virtue of the fact that it brings forth some of the best powers of mind and character, not because it develops mere bone and muscle.

Whether averages conceal or prove facts depends upon the interpretation of them. Dr. Sargent's charts would be more valuable to the public if he would give his data. The figures, by means of which the measurements of the "typical or normal standard" are derived, furnish the key to the chart. No man can test himself by the standard till he knows the standard measurements. The charts may be interesting and profitable as a private study, but can be of no benefit or authority to a single individual till Dr. Sargent discloses the measurements of the "typical man."

The real question with regard to athletics in the colleges, *as far as measurements are concerned*, is this: "What effect do athletics have upon the *growth* of athletes, as compared with the growth of those who are not athletes, but who are otherwise under similar conditions?"

To throw light on this question, the writer obtained from Dr. Seaver, of Yale College, two sets of measurements of members *of one class*, so as to ascertain the *growth for one year*. The first set of measurements was made soon after the class entered college, and the second set was taken in its sophomore year. Complete double measurements were procured from one hundred and two men, the remainder of the class—between twenty and thirty men—having neglected to submit to the second measurement. Of these, twenty-two were out-of-door athletes, and eighty were not, though they were under instruction in light gymnastics during a large part of their freshman year. The question, therefore, was considered under conditions as favorable as possible to Dr. Sargent's point of view. The results are presented graphically on page 729 and in numbers on page 730.

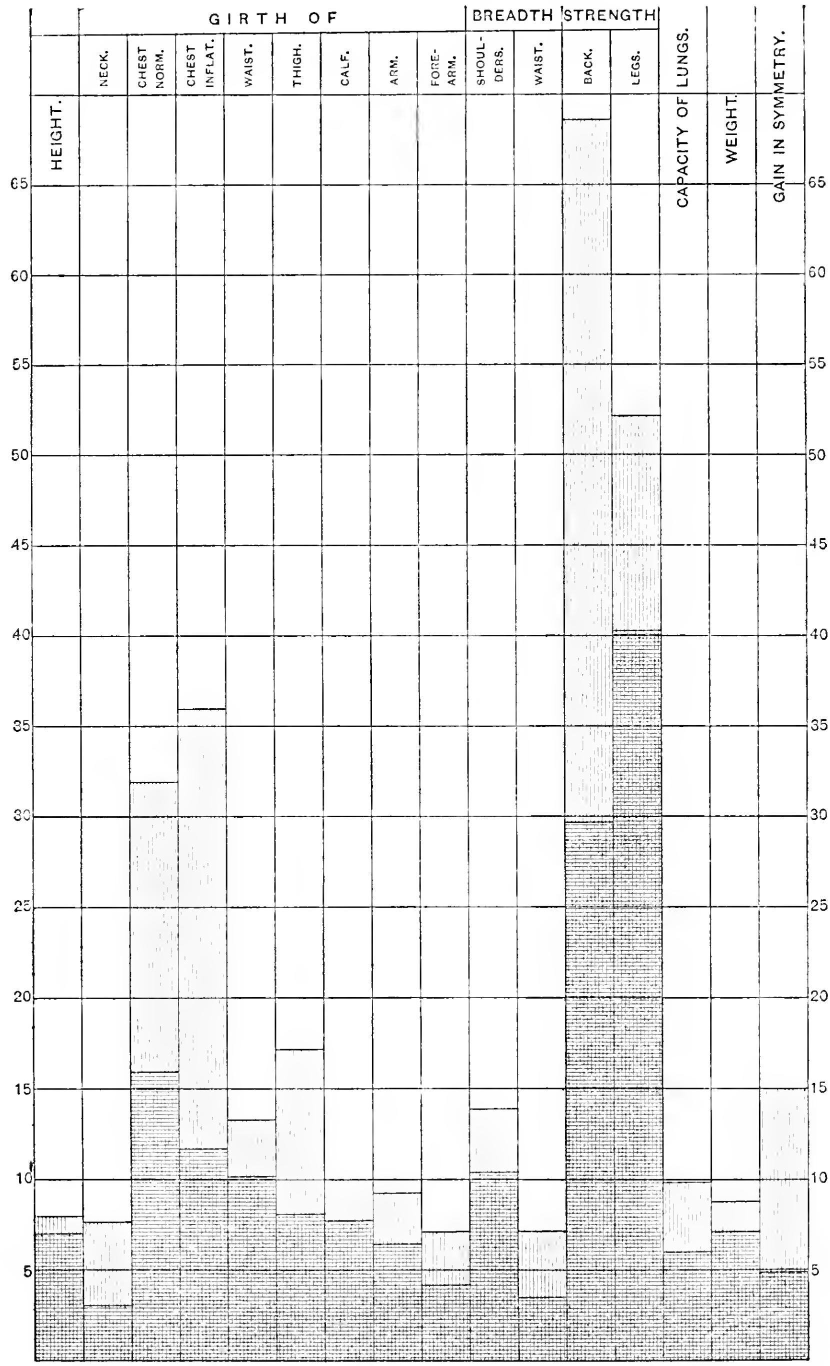
In the table, the items of *strength* of back and legs, and of weight, are given in pounds. Capacity of lungs is given in cubic inches. The other figures denote millimetres and tenths of millimetres.

The chart gives the average growth of the athletes as compared with the growth of the non-athletic men. The lighter parts of the chart indicate the excess of growth of one class above the growth of the other.

Of the twenty-two athletes two were base-ball players, six foot-ball players, six rowing-men, and eight were track-athletes. Of the foot-ball men five were also rowing-men. The averages are given for the four sets of men, as well as for the two classes (non-athletic and athletic), that the reader may see for himself how each kind of exercise has affected those taking it. The figures for the special athletes are derived from so small a number of men that they can hardly be taken as *conclusive*. They are merely *significant*. The small gain in the average of "strength of legs" of the foot-ball men was due to the loss of strength on the part of one man. Without him the remaining five gained an average of forty-eight pounds.

The growth of *girth of neck* of the athletes, in comparison with the same item for the non-athletic men, is worthy of attention. The gain in *strength of back* of the track-athletes, and their gain in *strength of arm*, ought to be noticed.

To test the question of symmetry of growth, the differences between the sizes of right arm and left arm, of right forearm and left forearm, of right thigh and left thigh, of right calf and left calf, were


GIRTH OF
BREADTH
STRENGTH
NECK.
CHEST NORM.
CHEST INFLAT.
WAIST.
THIGH.
CALF.
ARM.
FORE-ARM.
SHOUL-DERS.
WAIST.
BACK.
LEGS.
HEIGHT.
CAPACITY OF LUNGS.
WEIGHT.
GAIN IN SYMMETRY.
65
60
55
50
45
40
35
30
25
20
15
10
5

taken for *each year*. The sum of the differences of the second year (being less in both classes of students) was subtracted from the sum of the differences of the first year. The remainder was a gain in symmetry. This remainder, divided by the sum of the differences of the first year, gave the percentage of "gain in symmetry."

For One Class: Average Measurements of Growth during One Year.

GROWTH.	Rest of class: 80 non-athletes.	OUT-DOOR ATHLETES.				
		22 out-door athletes.	2 base-ball men.	6 foot-ball men.	6 rowing-men.	8 track-athletes.
Height	7·2 mm.	8 mm.	8·5 mm.	7·5 mm.	11·3 mm.	5·75 mm.
Girth of neck	3	7·7	6	11·3	5·7	7
Girth of chest (normal) . .	16·1	32·1	11	35·8	31·3	35·2
Girth of chest (inflated) .	11·7	36·2	15·5	33·8	40·7	39·7
Girth of waist	10·1	13·3	23	11	15·8	11·9
Girth of thigh	8	17·3	16	15·7	15·2	21·2
Girth of calf	7·6	10·1	11	12·8	10	7·9
Girth of arm	6·3	9·3	9	7·7	11	9·2
Girth of forearm	4·2	7·1	2·5	9·5	6·7	6·9
Breadth of shoulders . . .	10·1	13·8	12·5	11·5	11·7	17·4
Breadth of waist	3·4	7·2	10	5·5	6·8	8
Strength of back	29¾ lbs.	68·4 lb.	30 lbs.	55 lbs.	63⅔ lbs.	91⅞ lbs.
Strength of legs	40¼	52·3	45	19	51⅔	81⅞
Capacity of lungs	5·9 cu. in.	9·7 cu. in.	12·2 cu. in.	7·6 cu. in.	10·2 cu. in.	10·3 cu. in.
Weight	7·1 lbs.	8·7 lbs.	7¼ lbs.	9 lbs.	9·6 lbs.	8 2 lbs.
Gain in symmetry	4⅗ p. ct.	15 p. ct.	34 p. ct.	24 p. ct.	5½ p. ct.	4⅙ p. ct.

It must not be forgotten that the conditions of American life have changed so greatly in the last century that, in order to view education aright, it is necessary to take counsel of new considerations. To be sure, the material to be worked on seems to be the same. The youthful mind and character are unchanged. Yet there are influences at work in these modern times which are destined to sap the physical strength of our young men, and thus impair the vigor of their minds and emasculate their characters, unless these influences be clearly recognized and continually counteracted. We will mention two of these influences:

1. Concentration of Population into Cities.—According to the last census report, of every one hundred inhabitants in the United States, there were dwelling in towns of eight thousand inhabitants and above—

In 1790	3·3	In 1850	12·5
" 1820	4·9	" 1880	22·5

But these figures do not tell the whole story. Towns have grown into cities, and cities have added to their population enormously in the thirty years from 1850 to 1880, as will be seen from the following figures, showing the number of cities of various grades:

Number of Cities having Inhabitants of

IN	20,000 to 40,000.	40,000 to 75,000.	75,000 to 125,000.	125,000 to 250,000.	250,000 to 500,000.	500,000 to 1,000,000.	Over 1,000,000.
1850..............	14	7	3	3	1	1	0
1880..............	55	21	9	7	4	3	1

At the last census fifty cities held $15\frac{4}{10}$ per cent of the aggregate population of the country. Whatever may be said in favor of city life for adults, nothing can be said in favor of its influence upon the vigor or morals of young men. Life in the cities is faster than in the country. The incentives to excess in mental work are greater. The wear and tear of the nervous system is more intense. At the same time the opportunity or necessity of physical effort for the young men of the well-to-do classes is reduced to a minimum.

2. Increasing Knowledge demanding more Brain-Culture.—Thus increasing demands are made upon the brain and nerves by the faster life of the cities, and by the need of a better culture to meet the competitions of that life, while the opportunities are lessened for strengthening the body against these demands. When the population was extensively engaged in rural or mechanical pursuits, without the division of labor which now obtains, the bodies of our young men were hardened by toil and invigorated by life in the open air.

That the concentration of population is reflected in the attendance at our colleges can be established by an examination of catalogues. The fact is certainly evident at Yale University, as will be seen from the accompanying figures. Of every one hundred students in the catalogue, there were registered as coming from cities of thirty thousand inhabitants and upward—

IN CATALOGUE OF	Academic department.	Sheffield Scientific School.
1856–'57	$21\frac{1}{3}$	18
1871–'72	44	39
1886–'87	55	58

Anything that will help to counteract the disintegrating forces of city life, that will help to strengthen our city young men against the insidious forces of ill-health, against the forces of low-living, that will tend to keep young men out of disorders, out of crimes against self and society, is to be welcomed as an ally of the best education. I maintain that the system of athletics existing at our colleges and in our athletic clubs in all the cities of the land does this. It does more. Its work is not only to save but to form men. It helps our schools and colleges to send out into the world not merely scholarly ascetics, but men full of force and energy, men of strong fiber, physical and moral.

The modern gymnasium is a necessary auxiliary to every well-equipped college, but it owes much of its increasing usefulness and importance to the fact that it is a training-place for athletes. There is no real antagonism between the athletic field and the gymnasium. It is not necessary to depreciate one in order to exalt the other. Existing side by side, and both rightly used, they will best contribute to the evolution of the "typical man."

THE STRUGGLE FOR EXISTENCE: A PROGRAMME.

By Professor T. H. HUXLEY.

THE vast and varied procession of events which we call Nature affords a sublime spectacle and an inexhaustible wealth of attractive problems to the speculative observer. If we confine our attention to that aspect which engages the attention of the intellect, Nature appears a beautiful and harmonious whole, the incarnation of a faultless logical process, from certain premises in the past to an inevitable conclusion in the future. But if she be regarded from a less elevated, but more human, point of view; if our moral sympathies are allowed to influence our judgment, and we permit ourselves to criticise our great mother as we criticise one another—then our verdict, at least so far as sentient Nature is concerned, can hardly be so favorable.

In sober truth, to those who have made a study of the phenomena of life as they are exhibited by the higher forms of the animal world, the optimistic dogma that this is the best of all possible worlds will seem little better than a libel upon possibility. It is really only another instance to be added to the many extant, of the audacity of *a priori* speculators who, having created God in their own image, find no difficulty in assuming that the Almighty must have been actuated by the same motives as themselves. They are quite sure that, had any other course been practicable, he would no more have made infinite suffering a necessary ingredient of his handiwork than a respectable philosopher would have done the like.

But even the modified optimism of the time-honored thesis of physico-theology, that the sentient world is, on the whole, regulated by principles of benevolence, does but ill stand the test of impartial confrontation with the facts of the case. No doubt it is quite true that sentient Nature affords hosts of examples of subtle contrivances directed toward the production of pleasure or the avoidance of pain; and it may be proper to say that these are evidences of benevolence. But if so, why is it not equally proper to say of the equally numerous arrangements, the no less necessary result of which is the production of pain, that they are evidences of malevolence?

If a vast amount of that which, in a piece of human workmanship, we should call skill, is visible in those parts of the organization of a deer to which it owes its ability to escape from beasts of prey, there is at least equal skill displayed in that bodily mechanism of the wolf which enables him to track, and sooner or later to bring down, the deer. Viewed under the dry light of science, deer and wolf are alike admirable; and, if both were non-sentient automata, there would be nothing to qualify our admiration of the action of the one on the other. But the fact that the deer suffers while the wolf inflicts suffering engages our moral sympathies. We should call men like the deer innocent and good, men such as the wolf malignant and bad; we should call those who defended the deer and aided him to escape brave and compassionate, and those who helped the wolf in his bloody work base and cruel. Surely, if we transfer these judgments to Nature outside the world of man at all, we must do so impartially. In that case, the goodness of the right hand which helps the deer, and the wickedness of the left hand which eggs on the wolf, will neutralize one another; and the course of Nature will appear to be neither moral nor immoral, but non-moral.

This conclusion is thrust upon us by analogous facts in every part of the sentient world; yet, inasmuch as it not only jars upon prevalent prejudices, but arouses the natural dislike to that which is painful, much ingenuity has been exercised in devising an escape from it.

From the theological side, we are told that this is a state of probation, and that the seeming injustices and immoralities of Nature will be compensated by and by. But how this compensation is to be effected, in the case of the great majority of sentient things, is not clear. I apprehend that no one is seriously prepared to maintain that the ghosts of all the myriads of generations of herbivorous animals which lived during the millions of years of the earth's duration before the appearance of man, and which have all that time been tormented and devoured by carnivores, are to be compensated by a perennial existence in clover; while the ghosts of carnivores are to go to some kennel where there is neither a pan of water nor a bone with any meat on it. Besides, from the point of view of morality, the last state of things would be worse than the first. For the carnivores, however brutal and sanguinary, have only done that which, if there is any evidence of contrivance in the world, they were expressly constructed to do. Moreover, carnivores and herbivores alike have been subject to all the miseries incidental to old age, disease, and over-multiplication, and both might well put in a claim for "compensation" on this score.

On the evolutionist side, on the other hand, we are told to take comfort from the reflection that the terrible struggle for existence tends to final good, and that the suffering of the ancestor is paid for by the increased perfection of the progeny. There would be something in this argument if, in Chinese fashion, the present generation could pay its debts to its ancestors; otherwise, it is not clear what compensation the *Eohippus* gets for his sorrows in the fact that, some millions of years afterward, one of his descendants wins the Derby. And, again, it is an error to imagine that evolution signifies a constant tendency to increased perfection. That process undoubtedly involves a constant readjustment of the organism in adaptation to new conditions; but it depends on the nature of those conditions whether the direction of the modifications effected shall be upward or downward. Retrogressive is as practicable as progressive metamorphosis. If what the physical philosophers tell us, that our globe has been in a state of fusion, and, like the sun, is gradually cooling down, is true, then the time must come when evolution will mean adaptation to a universal winter, and all forms of life will die out, except such low and simple organisms as the diatom of the arctic and antarctic ice and the protococcus of the red snow. If our globe is proceeding from a condition in which it was too hot to support any but the lowest living thing to a condition in which it will be too cold to permit of the existence of any others, the course of life upon its surface must describe a trajectory like that of a ball fired from a mortar; and the sinking half of that course is as much a part of the general process of evolution as the rising.

From the point of view of the moralist the animal world is on about the same level as a gladiator's show. The creatures are fairly well treated, and set to fight—whereby the strongest, the swiftest, and the cunningest live to fight another day. The spectator has no need to turn his thumbs down, as no quarter is given. He must admit that the skill and training displayed are wonderful; but he must shut his eyes if he would not see that more or less enduring suffering is the meed of both vanquished and victor. And since the great game is going on in every corner of the world, thousands of times a minute; since, were our ears sharp enough, we need not descend to the gates of hell to hear—

"sospiri, pianti, ed alti guai,*

. . . .

Voci alte e fioche, e suon di man con elle"—†

it seems to follow that, if this world is governed by benevolence, it must be a different sort of benevolence from that of John Howard.

But the old Babylonians wisely symbolized Nature by their great goddess Istar, who combined the attributes of Aphrodite with those of Ares. Her terrible aspect is not to be ignored or covered up with shams; but it is not the only one. If the optimism of Leibnitz is a foolish though pleasant dream, the pessimism of Schopenhauer is a nightmare, the more foolish because of its hideousness. Error which is not pleasant is surely the worst form of wrong.

This may not be the best of all possible worlds, but to say that it

* Sighs, plaints, and loud cries.

† Voices loud and weak, and with them sounds of blows.

is the worst is mere petulant nonsense. A worn-out voluptuary may find nothing good under the sun, or a vain and inexperienced youth, who can not get the moon he cries for, may vent his irritation in pessimistic moanings; but there can be no doubt in the mind of any reasonable person that mankind could, would, and in fact do, get on fairly well with vastly less happiness and far more misery than find their way into the lives of nine people out of ten. If each and all of us had been visited by an attack of neuralgia, or of extreme mental depression, for one hour in every twenty-four—a supposition which many tolerably vigorous people know, to their cost, is not extravagant—the burden of life would have been immensely increased without much practical hindrance to its general course. Men with any manhood in them find life quite worth living under worse conditions than these.

There is another sufficiently obvious fact which renders the hypothesis that the course of sentient Nature is dictated by malevolence quite untenable. A vast multitude of pleasures, and these among the purest and the best, are superfluities, bits of good which are to all appearance unnecessary as inducements to live, and are, so to speak, thrown into the bargain of life. To those who experience them, few delights can be more entrancing than such as are afforded by natural beauty or by the arts, and especially by music; but they are products of, rather than factors in, evolution, and it is probable that they are known, in any considerable degree, to but a very small proportion of mankind.

The conclusion of the whole matter seems to be that, if Ormuzd has not had his way in this world, neither has Ahriman. Pessimism is as little consonant with the facts of sentient existence as optimism. If we desire to represent the course of Nature in terms of human thought, and assume that it was intended to be that which it is, we must say that its governing principle is intellectual and not moral; that it is a materialized logical process accompanied by pleasures and pains, the incidence of which, in the majority of cases, has not the slightest reference to moral desert. That the rain falls alike upon the just and the unjust, and that those upon whom the Tower of Siloam fell were no worse than their neighbors, seem to be Oriental modes of expressing the same conclusion.

In the strict sense of the word "Nature," it denotes the sum of the phenomenal world, of that which has been, and is, and will be; and society, like art, is therefore a part of Nature. But it is convenient to distinguish those parts of Nature in which man plays the part of immediate cause, as something apart; and, therefore, society, like art, is usefully to be considered as distinct from Nature. It is the more desirable, and even necessary, to make this distinction, since society differs from Nature in having a definite moral object; whence it comes about that the course shaped by the ethical man—the member of society or citizen—necessarily runs counter to that which the non-ethical man—the primitive savage, or man as a mere member of the animal kingdom—tends to adopt. The latter fights out the struggle for existence to the bitter end, like any other animal; the former devotes his best energies to the object of setting limits to the struggle.

In the cycle of phenomena presented by the life of man, the animal, no more moral end is discernible than in that presented by the lives of the wolf and of the deer. However imperfect the relics of prehistoric men may be, the evidence which they afford clearly tends to the conclusion that, for thousands and thousands of years, before the orgin of the oldest known civilizations, men were savages of a very low type. They strove with their enemies and their competitors; they preyed upon things weaker or less cunning than themselves; they were born, multiplied without stint, and died, for thousands of generations, alongside the mammoth, the urus, the lion, and the hyena, whose lives were spent in the same way; and they were no more to be praised or blamed, on moral grounds, than their less erect and more hairy compatriots.

As among these, so among primitive men, the weakest and stupidest went to the wall, while the toughest and shrewdest, those who were best fitted to cope with their circumstances, but not the best in any other sense, survived. Life was a continual free fight, and beyond the limited and temporary relations of the family, the Hobbesian war of each against all was the normal state of existence. The human species, like others, plashed and floundered amid the general stream of evolution, keeping its head above water as it best might, and thinking neither of whence nor whither.

The history of civilization—that is, of society—on the other hand, is the record of the attempts which the human race has made to escape from this position. The first men who substituted the state of mutual peace for that of mutual war, whatever the motive which impelled them to take that step, created society. But, in establishing peace, they obviously put a limit upon the struggle for existence. Between the members of that society, at any rate, it was not to be pursued *à outrance*. And of all the successive shapes which society has taken, that most nearly approaches perfection in which the war of individual against individual is most strictly limited. The primitive savage, tutored by Istar, appropriated whatever took his fancy, and killed whomsoever opposed him, if he could. On the contrary, the ideal of the ethical man is to limit his freedom of action to a sphere in which he does not interfere with the freedom of others; he seeks the common weal as much as his own; and, indeed, as an essential part of his own welfare. Peace is both end and means with him; and he founds his life on a more or less complete self-restraint, which is the negation of the struggle for existence. He tries to escape from his place in the animal kingdom, founded on the free development of the principle of non-moral evolution, and to found a kingdom of Man, governed upon the principle of moral evolution. For society not only has a moral end, but in its perfection, social life, is embodied morality.

But the effort of ethical man to work toward a moral end by no means abolished, perhaps has hardly modified, the deep-seated organic impulses which impel the natural man to follow his non-moral course. One of the most essential conditions, if not the chief cause, of the struggle for existence, is the tendency to multiply without limit, which man shares with all living things. It is notable that "increase and multiply" is a commandment traditionally much older than the ten, and that it is, perhaps, the only one which has been spontaneously and *ex animo* obeyed by the great majority of the human race. But, in civilized society, the inevitable result of such obedience is the re-establishment, in all its intensity, of that struggle for existence—the war of each against all—the mitigation or abolition of which was the chief end of social organization.

It is conceivable that, at some period in the history of the fabled Atlantis, the production of food should have been exactly sufficient to meet the wants of the population, that the makers of artificial commodities should have amounted to just the number supportable by the surplus food of the agriculturists. And, as there is no harm in adding another monstrous supposition to the foregoing, let it be imagined that every man, woman, and child was perfectly virtuous, and aimed at the good of all as the highest personal good. In that happy land, the natural man would have been finally put down by the ethical man. There would have been no competition, but the industry of each would have been serviceable to all; nobody being vain and nobody avaricious, there would have been no rivalries; the struggle for existence would have been abolished, and the millennium would have finally set in. But it is obvious that this state of things could have been permanent only with a stationary population. Add ten fresh mouths; and as, by the supposition, there was only exactly enough before, somebody must go on short rations. The Atlantis society might have been a heaven upon earth, the whole nation might have consisted of just men, needing no repentance, and yet somebody must starve. Reckless Istar, non-moral Nature, would have riven the social fabric. I was once talking with a very eminent physician about the *vis medicatrix naturæ.* "Stuff!" said he; "nine times out of ten Nature does not want to cure the man; she wants to put him in his coffin." And Istar-Nature appears to have equally little sympathy with the needs of society. "Stuff! she wants nothing but a fair field and free play for her darling the strongest."

Our Atlantis may be an impossible figment, but the antagonistic tendencies which the fable adumbrates have existed in every society which was ever established, and, to all appearance, must strive for the victory in all that will be. Historians point to the greed and ambition of rulers, to the reckless turbulence of the ruled, to the debasing effects of wealth and luxury, and to the devastating wars which have formed a great part of the occupation of mankind, as the causes of the decay of states and the foundering of old civilizations, and thereby point their story with a moral. No doubt immoral motives of all sorts have figured largely among the minor causes of these events. But, beneath all this superficial turmoil, lay the deep-seated impulse given by unlimited multiplication. In the swarms of colonies thrown out by Phœnicia and by old Greece; in the "ver sacrum" of the Latin races; in the floods of Gauls and of Teutons which burst over the frontiers of the old civilization of Europe; in the swaying to and fro of the vast Mongolian hordes in late times, the population problem comes to the front in a very visible shape. Nor is it less plainly manifest in the everlasting agrarian questions of ancient Rome than in the Arreoi societies of the Polynesian Islands.

In the ancient world and in a large part of that in which we now live, the practice of infanticide was or is a regular and legal custom; the steady recurrence of famine, pestilence, and war were and are normal factors in the struggle for existence, and have served, in a gross and brutal fashion, to mitigate the intensity of its chief cause.

But, in the more advanced civilizations, the progress of private and public morality has steadily tended to remove all these checks. We declare infanticide murder, and punish it as such; we decree, not quite successfully, that no one shall die of hunger; we regard death from preventable causes of other kinds as a sort of constructive murder, and eliminate pestilence to the best of our ability; we declaim against the curse of war and the wickedness of the military spirit, and we are never weary of dilating on the blessedness of peace and the innocent beneficence of industry. In their moments of expansion, even statesmen and men of business go thus far. The finer spirits look to an ideal "civitas Dei"; a state when, every man having reached the point of absolute self-negation, and having nothing but moral perfection to strive after, peace will truly reign, not merely among nations, but among men, and the struggle for existence will be at an end.

Whether human nature is competent, under any circumstances, to reach, or even seriously advance toward, this ideal condition, is a question which need not be discussed. It will be admitted that mankind has not yet reached this stage by a very long way, and my business is with the present. And that which I wish to point out is that, so long as the natural man increases and multiplies without restraint, so long will peace and industry not only permit, but they will necessitate, a struggle for existence as sharp as any that ever went on under the *régime* of war. If Istar is to reign on the one hand, she will demand her human sacrifices on the other.

Let us look at home. For seventy years, peace and industry have had their way among us with less interruption and under more favorable conditions than in any other country on the face of the earth. The wealth of Crœsus was nothing to that which we have accumulated, and our prosperity has filled the world with envy. But Nemesis did not forget Crœsus; has she forgotten us?

I think not. There are now thirty-six millions of people in our island, and every year considerably more than three hundred thousand are added to our numbers.* That is to say, about every hundred seconds, or so, a new claimant to a share in the common stock of maintenance presents him or herself among us. At the present time, the produce of the soil does not suffice to feed half its population. The other moiety has to be supplied with food which must be bought from the people of food-producing countries. That is to say, we have to offer them the things which they want in exchange for the things we want. And the things they want and which we can produce better than they can are mainly manufactures—industrial products.

The insolent reproach of the first Napoleon had a very solid foundation. We not only are, but, under penalty of starvation, we are bound to be, a nation of shopkeepers. But other nations also lie under the same necessity of keeping shop, and some of them deal in the same goods as ourselves. Our customers naturally seek to get the most and the best in exchange for their produce. If our goods are inferior to those of our competitors, there is no ground compatible with the sanity of the buyers, which can be alleged, why they should not prefer the latter. And, if that result should ever take place on a large and general scale, five or six millions of us would soon have nothing to eat. We know what the cotton famine was; and we can therefore form some notion of what a dearth of customers would be.

Judged by an ethical standard, nothing can be less satisfactory than the position in which we find ourselves. In a real, though incomplete, degree we have attained the condition of peace which is the main object of social organization; and it may, for argument's sake, be assumed that we desire nothing but that which is in itself innocent and praiseworthy—namely, the enjoyment of the fruits of honest industry. And lo! in spite of ourselves, we are in reality engaged in an internecine struggle for existence with our presumably no less peaceful and well-meaning neighbors. We seek peace and we do not ensue it. The moral nature in us asks for no more than is compatible with the general good; the non-moral nature proclaims and acts upon that fine old Scottish family motto, "Thou shalt starve ere I want." Let us be under no illusions, then. So long as unlimited multiplication goes on, no social organization which has ever been devised, or is

* These numbers are only approximately accurate. In 1881 our population amounted to 35,241,482, exceeding the number in 1871 by 3,396,103. The average annual increase in the decennial period 1871-1881 is therefore 339,610. The number of minutes in a calendar year is 525,600.

likely to be devised; no fiddle-faddling with the distribution of wealth, will deliver society from the tendency to be destroyed by the reproduction within itself, in its intensest form, of that struggle for existence, the limitation of which is the object of society. And however shocking to the moral sense this eternal competition of man against man and of nation against nation may be; however revolting may be the accumulation of misery at the negative pole of society, in contrast with that of monstrous wealth at the positive pole; this state of things must abide, and grow continually worse, so long as Istar holds her way unchecked. It is the true riddle of the Sphinx; and every nation which does not solve it will sooner or later be devoured by the monster itself has generated.

The practical and pressing question for us just now seems to me to be how to gain time. "Time brings counsel," as the Teutonic proverb has it; and wiser folk among our posterity may see their way out of that which at present looks like an *impasse.*

It would be folly to entertain any ill-feeling toward those neighbors and rivals who, like ourselves, are slaves of Istar; but, if somebody is to be starved, the modern world has no Oracle of Delphi to which the nations can appeal for an indication of the victim. It is open to us to try our fortune; and if we avoid impending fate, there will be a certain ground for believing that we are the right people to escape. *Securus judicat orbis.*

To this end, it is well to look into the necessary conditions of our salvation by works. They are two, one plain to all the world and hardly needing insistence; the other seemingly not so plain, since too often it has been theoretically and practically left out of sight. The obvious condition is that our produce shall be better than that of others. There is only one reason why our goods should be preferred to those of our rivals—our customers must find them better at the price. That means that we must use more knowledge, skill, and industry in producing them, without a proportionate increase in the cost of production; and, as the price of labor constitutes a large element in that cost, the rate of wages must be restricted within certain limits. It is perfectly true that cheap production and cheap labor are by no means synonymous; but it is also true that wages can not increase beyond a certain proportion without destroying cheapness. Cheapness, then, with, as part and parcel of cheapness, a moderate price of labor, is essential to our success as competitors in the markets of the world.

The second condition is really quite as plainly indispensable as the first, if one thinks seriously about the matter. It is social stability. Society is stable when the wants of its members obtain as much satisfaction as, life being what it is, common sense and experience show may be reasonably expected. Mankind, in general, care very little for forms of government or ideal considerations of any sort; and nothing really stirs the great multitude of mankind to break with custom and incur the manifest perils of revolt except the belief that misery in this world or damnation in the next, or both, are threatened by the continuance of the state of things in which they have been brought up. But when they do attain that conviction, society becomes as unstable as a package of dynamite, and a very small matter will produce the explosion which sends it back to the chaos of savagery.

It needs no argument to prove that, when the price of labor sinks below a certain point, the worker infallibly falls into that condition which the French emphatically call *la misère*—a word for which I do not think there is any exact English equivalent. It is a condition in which the food, warmth, and clothing which are necessary for the mere maintenance of the functions of the body in their normal state can not be obtained; in which men, women, and children are forced to crowd into dens wherein decency is abolished and the most ordinary conditions of healthful existence are impossible of attainment; in which the pleasures within reach are reduced to bestiality and drunkenness; in which the pains accumulate at compound interest, in the shape of starvation, disease, stunted development, and moral degradation; in which the prospect of even steady and honest industry is a life of unsuccessful battling with hunger, rounded by a pauper's grave.

That a certain proportion of the members of every great aggregation of mankind should constantly tend to establish and populate such a *Malebolge* as this is inevitable, so long as some people are by nature idle and vicious, while others are disabled by sickness or accident, or thrown upon the world by the death of their bread-winners. So long as that proportion is restricted within tolerable limits, it can be dealt with; and, so far as it arises only from such causes, its existence may and must be patiently borne. But, when the organization of society, instead of mitigating this tendency, tends to continue and intensify it; when a given social order plainly makes for evil and not for good, men naturally enough begin to think it high time to try a fresh experiment. The animal man, finding that the ethical man has landed him in such a slough, resumes his ancient sovereignty and preaches anarchy; which is, substantially, a proposal to reduce the social cosmos to chaos and begin the brute struggle for existence once again.

Any one who is acquainted with the state of the population of all great industrial centers, whether in this or other countries, is aware that, amid a large and increasing body of that population, *la misère* reigns supreme. I have no pretensions to the character of a philanthropist, and I have a special horror of all sorts of sentimental rhetoric; I am merely trying to deal with facts, to some extent within my own knowledge, and further evidenced by abundant testimony, as a naturalist; and I take it to be a mere plain truth that, throughout industrial Europe, there is not a single large manufacturing city which is free from a vast mass of people whose condition is exactly that described, and from a still greater mass who, living just on the edge of the social swamp, are liable to be precipitated into it by any lack of demand for their produce. And, with every addition to the population, the multitude already sunk in the pit and the number of the host sliding toward it continually increase.

Argumentation can hardly be needful to make it clear that no society in which the elements of decomposition are thus swiftly and surely accumulating can hope to win in the race of industries.

Intelligence, knowledge, and skill are undoubtedly conditions of success; but of what avail are they likely to be unless they are backed up by honesty, energy, good-will, and all the physical and moral faculties that go to the making of manhood, and unless they are stimulated by hope of such reward as men may fairly look to? And what dweller in the slough of *misère*, dwarfed in body and soul, demoralized, hopeless, can reasonably be expected to possess these qualities?

Any full and permanent development of the productive powers of an industrial population, then, must be compatible with, and, indeed, based upon a social organization which will secure a fair amount of physical and moral welfare to that population; which will make for good and not for evil. Natural science and religious enthusiasm rarely go hand in hand, but on this matter their concord is complete; and the least sympathetic of naturalists can but admire the insight and the devotion of such social reformers as the late Lord Shaftesbury, whose recently published "Life and Letters" gives a vivid picture of the condition of the working classes fifty years ago, and of the pit which our industry, ignoring these plain truths, was then digging under its own feet.

There is perhaps no more hopeful sign of progress among us in the last half-century than the steadily increasing devotion which has been and is directed to measures for promoting physical and moral welfare among the poorer classes. Sanitary reformers, like most other reformers whom I have had the advantage of knowing, seem to need a good dose of fanaticism, as a sort of moral coca, to keep them up to the mark, and, doubtless, they have made many mistakes; but that the endeavor to improve the condition under which our industrial population live, to amend the drainage of densely peopled streets, to provide baths, wash-houses, and gymnasia, to facilitate habits of thrift, to furnish some provision for instruction and amusement in public libraries and the like, is not only desirable from a philanthropic point of view, but an essential condition of safe industrial development, appears to me to be indisputable. It is by such means alone, so far as I can see, that we can hope to check the constant gravitation of industrial society toward *la misère*, until the general progress of intelligence and morality leads men to grapple with the sources of that tendency. If it is said that the carrying out of such arrangements as those indicated must enhance the cost of production, and thus handicap the producer in the race of competition, I venture, in the first place, to doubt the fact; but if it be so, it results that industrial society has to face a dilemma, either horn of which threatens impalement.

On the one hand, a population whose labor is sufficiently remunerated may be physically and morally healthy and socially stable, but may fail in industrial competition by reason of the dearness of its produce. On the other hand, a population whose labor is insufficiently remunerated must become physically and morally unhealthy, and socially unstable; and though it may succeed for a while in industrial competition, by reason of the cheapness of its produce, it must in the end fall, through hideous misery and degradation, to utter ruin.

Well, if these are the only possible alternatives, let us for ourselves and our children choose the former, and, if need be, starve like men. But I do not believe that a stable society made up of healthy, vigorous, instructed, and self-ruling people would ever incur serious risk of that fate. They are not likely to be troubled with many competitors of the same character, and they may be safely trusted to find ways of holding their own.

Assuming that the physical and moral well-being and the stable social order, which are the indispensable conditions of permanent industrial development, are secured, there remains for consideration the means of attaining that knowledge and skill, without which, even then, the battle of competition can not be successfully fought. Let us consider how we stand. A vast system of elementary education has now been in operation among us for sixteen years, and has reached all but a very small fraction of the population. I do not think that there is any room for doubt that, on the whole, it has worked well, and that its indirect no less than its direct benefits have been immense. But, as might be expected, it exhibits the defects of all our educational systems—fashioned as they were to meet the wants of a by-gone condition of society. There is a wides-pread, and I think well-justified, complaint that it has too much to do with books and too little to do with things. I am as little disposed as any one can well be to narrow early education and to make the primary school a mere annex of the shop. And it is not so much in the interests of industry as in that of breadth of culture, that I echo the common complaint against the bookish and theoretical character of our primary instruction.

If there were no such things as industrial pursuits, a system of education which does nothing for the faculties of observation, which trains neither the eye nor the hand, and is compatible with utter ignorance of the commonest natural truths, might still be reasonably regarded as strangely imperfect. And when we consider that the instruction and training which are lacking are exactly those which are of most importance for the great mass of our population, the fault becomes almost a crime, the more that there is no practical difficulty in making good these defects. There really is no reason why drawing should not be universally taught, and it is an admirable training for both eye and hand. Artists are born, not made; but everybody may be taught to draw elevations, plans, and sections; and pots and pans are as good, indeed better, models for this purpose than the Apollo Belvedere. The plant is not expensive; and there is this excellent quality about drawing of the kind indicated, that it can be tested almost as easily and severely as arithmetic. Such drawings are either right or wrong, and if they are wrong the pupil can be made to see that they are wrong. From the industrial point of view, drawing has the further merit that there is hardly any trade in which the power of drawing is not of daily and hourly utility. In the next place, no good reason, except the want of capable teachers, can be assigned why elementary notions of science should not be an element in general instruction. In this case, again, no experience or elaborate apparatus is necessary. The commonest thing—a candle, a boy's squirt, a piece of chalk—in the hands of a teacher who knows his business may be made the starting-points whence children may be led into the regions of science as far as their capacity permits, with efficient exercise of their observational and reasoning faculties on the road. If object-lessons often prove trivial failures, it is not the fault of object-lessons, but that of the teacher, who has not found out how much the power of teaching a little depends on knowing a great deal, and that thoroughly; and that he has not made that discovery is not the fault of the teachers, but of the detestable system of training them which is widely prevalent.*

As I have said, I do not regard the proposal to add these to the present subjects of universal instruction, as made merely in the interests of industry. Elementary science and drawing are just as needful at Eton (where I am happy to say both are now parts of the regular course) as in the lowest primary school. But their importance in the education of the artisan is enhanced, not merely by the fact that the knowledge and skill thus gained—little as they may amount to—will still be of practical utility to him; but further, because they constitute an introduction to that special training which is commonly called "technical education."

I conceive that our wants in this last direction may be grouped under four heads: (1) Instruction in the principles of those branches of science and of art which are peculiarly applicable to industrial pursuits, which may be called preliminary scientific education. (2) In-

* Training in the use of simple tools is no doubt very desirable, on all grounds. From the point of view of "culture," the man whose "fingers are all thumbs" is but a stunted creature. But the practical difficulties in the way of introducing handiwork of this kind into elementary schools appear to me to be considerable.

struction in the special branches of such applied science and art, as technical education proper. (3) Instruction of teachers in both these branches. (4) Capacity-catching machinery.

A great deal has already been done in each of these directions, but much remains to be done. If elementary education is amended in the way that has been suggested, I think that the school-boards will have quite as much on their hands as they are capable of doing well. The influences under which the members of these bodies are elected do not tend to secure fitness for dealing with scientific or technical education; and it is the less necessary to burden them with an uncongenial task as there are other organizations, not only much better fitted to do the work, but already actually doing it.

In the matter of preliminary scientific education, the chief of these is the Science and Art Department, which has done more during the last quarter of a century for the teaching of elementary science among the masses of the people than any organization which exists either in this or in any other country. It has become veritably a people's university, so far as physical science is concerned. At the foundation of our old universities they were freely open to the poorest, but the poorest must come to them. In the last quarter of a century, the Science and Art Department, by means of its classes spread all over the country and open to all, has conveyed instruction to the poorest. The University Extension movement shows that our older learned corporations have discovered the propriety of following suit.

Technical education, in the strict sense, has become a necessity for two reasons. The old apprenticeship system has broken down, partly by reason of the changed conditions of industrial life, and partly because trades have ceased to be "crafts," the traditional secrets whereof the master handed down to his apprentices. Invention is constantly changing the face of our industries, so that "use and wont," "rule of thumb," and the like, are gradually losing their importance, while that knowledge of principles which alone can deal successfully with changed conditions is becoming more and more valuable. Socially, the "master" of four or five apprentices is disappearing in favor of the "employer" of forty, or four hundred, or four thousand "hands," and the odds and ends of technical knowledge, formerly picked up in a shop, are not, and can not be, supplied in the factory. The instruction formerly given by the master must therefore be more than replaced by the systematic teaching of the technical school.

Institutions of this kind on varying scales of magnitude and completeness, from the splendid edifice set up by the City and Guilds Institute to the smallest local technical school, to say nothing of classes, such as those in technology instituted by the Society of Arts (subsequently taken over by the City Guilds), have been established in various parts of the country, and the movement in favor of their increase and multiplication is rapidly growing in breadth and intensity. But there is much difference of opinion as to the best way in which the technical instruction, so generally desired, should be given. Two courses appear to be practicable: the one is the establishment of special technical schools with a systematic and lengthened course of instruction demanding the employment of the whole time of the pupils. The other is the setting afoot of technical classes, especially evening classes, comprising a short series of lessons on some special topic, which may be attended by persons already earning wages in some branch of trade or commerce.

There is no doubt that technical schools, on the plan indicated under the first head, are extremely costly; and, so far as the teaching of artisans is concerned, it is very commonly objected to them that, as the learners do not work under trade conditions, they are apt to fall into amateurish habits, which prove of more hindrance than service in the actual business of life. When such schools are attached to factories under the direction of an employer who desires to train up a supply of intelligent workmen, of course this objection does not apply; nor can the usefulness of such schools for the training of future employers and for the higher grade of the employed be doubtful; but they are clearly out of the reach of the great mass of the people, who have to earn their bread as soon as possible. We must therefore look to the classes, and especially to the evening classes, as the great instrument for the technical education of the artisan. The utility of such classes has now been placed beyond all doubt; the only question which remains is to find the ways and means of extending them.

We are here, as in all other questions of social organization, met by two diametrically opposed views. On the one hand, the methods pursued in foreign countries are held up as our example. The state is exhorted to take the matter in hand, and establish a great system of technical education. On the other hand, many economists of the individualist school exhaust the resources of language in condemning and repudiating, not merely the interference of the general government in such matters, but the application of a farthing of the funds raised by local taxation to these purposes. I entertain a strong conviction that, in this country, at any rate, the state had much better leave purely technical and trade instruction alone. But, although my personal leanings are decidedly toward the individualists, I have arrived at that conclusion on merely practical grounds. In fact, my individualism is rather of a sentimental sort, and I sometimes think I should be stronger in the faith if it were less vehemently advocated.* I am unable to see that civil society is anything but a corporation established for a moral object—namely, the good of its members—

* In what follows I am only repeating and emphasizing opinions which I expressed, seventeen years ago, in an address to the members of the Midland Institute (republished in "Critiques and Addresses" in 1873). I have seen no reason to modify them, notwithstanding high authority on the other side.

and therefore that it may take such measures as seem fitting for the attainment of that which the general voice decides to be the general good. That the suffrage of the majority is by no means a scientific test of social good and evil is unfortunately too true; but, in practice, it is the only test we can apply, and the refusal to abide by it means anarchy. The purest despotism that ever existed is as much based upon that will of the majority (which is usually submission to the will of a small minority) as the freest republic. Law is the expression of the opinion of the majority, and it is law, and not mere opinion, because the many are strong enough to enforce it.

I am as strongly convinced as the most pronounced individualist can be, that it is desirable that every man should be free to act in every way which does not limit the corresponding freedom of his fellow-man. But I fail to connect that great induction of sociology with the practical corollary which is frequently drawn from it; that the state—that is, the people in its corporate capacity—has no business to meddle with anything but the administration of justice and external defense.

It appears to me that the amount of freedom which incorporate society may fitly leave to its members is not a fixed quantity, to be determined *a priori* by deduction from the fiction called "natural rights"; but that it must be determined by, and vary with, circumstances.

I conceive it to be demonstrable that the higher and the more complex the organization of the social body, the more closely is the life of each member bound up with that of the whole; and the larger becomes the category of acts which cease to be merely self-regarding, and which interfere with the freedom of others more or less seriously.

If a squatter, living ten miles away from any neighbor, chooses to burn his house down to get rid of vermin, there may be no necessity (in the absence of insurance-offices) that the law should interfere with his freedom of action. His act can hurt nobody but himself; but if the dweller in a street chooses to do the same thing, the state very properly makes such a proceeding a crime, and punishes it as such. He does meddle with his neighbor's freedom, and that seriously. So it might, perhaps, be a tenable doctrine that it would be needless, and even tyrannous, to make education compulsory in a sparse agricultural population, living in abundance on the produce of its own soil; but, in a densely populated manufacturing country, struggling for existence with competitors, every ignorant person tends to become a burden upon, and, so far, an infringer of the liberty of, his fellows, and an obstacle to their success.

Under such circumstances an education rate is, in fact, a war-tax, levied for purposes of defense.

That state action always has been more or less misdirected, and always will be so, is, I believe, perfectly true. But I am not aware that it is more true of the action of men in their corporate capacity than it is of the doings of individuals. The wisest and most dispassionate man in existence, merely wishing to go from one stile in a field to the opposite, will not walk quite straight—he is always going a little wrong, and always correcting himself; and I can only congratulate the individualist who is able to say that his general course of life has been of a less undulating character. To abolish state action, because its direction is never more than approximately correct, appears to me to be much the same thing as abolishing the man at the wheel altogether, because, do what he will, the ship yaws more or less. "Why should I be robbed of my property to pay for teaching another man's children?" is an individualist question, which is not unfrequently put as if it settled the whole business. Perhaps it does, but I find difficulties in seeing why it should. The parish in which I live makes me pay my share for the paving and lighting of a great many streets that I never pass through; and I might plead that I am robbed to smooth the way and lighten the darkness of other people. But I am afraid the parochial authorities would not let me off on this plea; and I must confess I do not see why they should.

I can not speak of my own knowledge, but I have every reason to believe that I came into this world a small reddish person, certainly without a gold spoon in my mouth, and in fact with no discernible abstract or concrete "rights" or property of any description. If a foot was not, at once, set upon me as a squalling nuisance, it was either the natural affection of those about me, which I certainly had done nothing to deserve, or the fear of the law which, ages before my birth, was painfully built up by the society into which I intruded, that prevented that catastrophe. If I was nourished, cared for, taught, saved from the vagabondage of a wastrel, I certainly am not aware that I did anything to deserve those advantages. And, if I possess anything now, it strikes me that, though I may have fairly earned my day's wages for my day's work, and may justly call them my property—yet, without that organization of society, created out of the toil and blood of long generations before my time, I should probably have had nothing but a flint axe and an indifferent hut to call my own; and even those would be mine only so long as no stronger savage came my way.

So that if society, having—quite gratuitously—done all these things for me, asks me in turn to do something toward its preservation—even if that something is to contribute to the teaching of other men's children—I really, in spite of all my individualist leanings, feel rather ashamed to say no. And if I were not ashamed, I can not say that I think that society would be dealing unjustly with me in converting the moral obligation into a legal one. There is a manifest unfairness in letting all the burden be borne by the willing horse.

It does not appear to me, then, that there is any valid objection to taxation for purposes of education; but, in the case of technical schools and classes, I think it is practically expedient that such taxation should be local. Our industrial population accumulates in particular towns and districts; these districts are those which immediately profit by technical education; and it is only in them that we can find the men practically engaged in industries, among whom some may reasonably be expected to be competent judges of that which is wanted, and of the best means of meeting the want.

In my belief, all methods of technical training are at present tentative, and, to be successful, each must be adapted to the special peculiarities of its locality. This is a case in which we want twenty years; not of "strong government," but of cheerful and hopeful blundering; and we may be thankful if we get things straight in that time.

The principle of the bill introduced, but dropped, by the Government last session, appears to me to be wise, and some of the objections to it I think are due to a misunderstanding. The bill proposed in substance to allow localities to tax themselves for purposes of technical education—on the condition that any scheme for such purpose should be submitted to the Science and Art Department, and declared by that department to be in accordance with the intention of the legislature.

A cry was raised that the bill proposed to throw technical education into the hands of the Science and Art Department. But, in reality, no power of initiation, nor even of meddling with details, was given to that department—the sole function of which was to decide whether any plan proposed did or did not come within the limits of "technical education." The necessity for such control, somewhere, is obvious. No legislature, certainly not ours, is likely to grant the power of self-taxation without setting limits to that power in some way; and it would neither have been practicable to devise a legal definition of technical education, nor commendable to leave the question to the Auditor-General to be fought out in the law courts. The only alternative was to leave the decision to an appropriate state authority. If it is asked, What is the need of such control if the people of the localities are the best judges? the obvious reply is that there are localities and localities, and that while Manchester, or Liverpool, or Birmingham, or Glasgow, might, perhaps, be safely left to do as they thought fit, smaller towns, in which there is less certainty of full discussion by competent people of different ways of thinking, might easily fall a prey to crotcheteers.

Supposing our intermediate science-teaching and our technical schools and classes are established, there is yet a third need to be supplied, and that is the want of good teachers. And it is necessary not only to get them, but to keep them when you have got them.

It is impossible to insist too strongly upon the fact that efficient teachers of science and of technology are not to be made by the processes in vogue at ordinary training colleges. The memory loaded with mere book-work is not the thing wanted—is, in fact, rather worse than useless—in the teacher of scientific subjects. It is absolutely essential that his mind should be full of knowledge and not of mere learning, and that what he knows should have been learned in the laboratory rather than in the library. There are happily already, both in London and in the provinces, various places in which such training is to be had, and the main thing at present is to make it in the first place accessible, and in the next indispensable, to those who undertake the business of teaching. But when the well-trained men are supplied, it must be recollected that the profession of teacher is not a very lucrative or otherwise tempting one, and that it may be advisable to offer special inducements to good men to remain in it. These, however, are questions of detail into which it is unnecessary to enter further.

Last, but not least, comes the question of providing the machinery for enabling those who are by nature specially qualified to undertake the higher branches of industrial work, to reach the position in which they may render that service to the community. If all our educational expenditure did nothing but pick one man of scientific or inventive genius, each year, from amid the hewers of wood and drawers of water, and give him the chance of making the best of his inborn faculties, it would be a very good investment. If there is one such child among the hundreds of thousands of our annual increase, it would be worth any money to drag him either from the slough of misery or from the hot-bed of wealth, and teach him to devote himself to the service of his people. Here, again, we have made a beginning with our scholarships and the like, and need only follow in the tracks already worn.

The programme of industrial development briefly set forth in the preceding pages is not what Kant calls a "Hirngespinnst," a cobweb spun in the brain of a Utopian philosopher. More or less of it has taken bodily shape in many parts of the country, and there are towns of no great size or wealth in the manufacturing districts (Keighley, for example) in which almost the whole of it has, for some time, been carried out so far as the means at the disposal of the energetic and public-spirited men who have taken the matter in hand, permitted. The thing can be done; I have endeavored to show good grounds for the belief that it must be done, and that speedily, if we wish to hold our own in the war of industry. I doubt not that it will be done, whenever its absolute necessity becomes as apparent to all those who are absorbed in the actual business of industrial life as it is to some of the lookers-on.—*Nineteenth Century.*

The Bishop of Manchester remarked, in a sermon, during the meeting of the British Association in that city, that science had led Christians to discover how very gravely the New Testament had been misrepresented by the popular Christianity, and it had revolutionized the study of the Word of God.

FORMS AND FAILURES OF THE LAW.

BY PHILIP SNYDER.

THE law's delay has long been a theme for comment, gibe, criticism, and denunciation. Even lawyers and judges discuss it occasionally, in published papers and orations at bar association meetings, but with no radical results. The abuse goes on, and doubtless will until those who suffer from it, the people, take the matter in their own hands and move for redress. They are thoroughly satisfied as to its necessity, but what is most wanted is leadership. Able and unselfish lawyers, if such can be found for it, would here find a promising field for honorable fame. But if there are none to volunteer, the reform will go on without them, and will not stop with the law's delays alone, which are trifling in comparison with the work that needs to be done.

Judge William L. Learned, of the New York State Supreme Court, in a paper on "The Law's Delays," makes an admission of striking significance. He says: "In most things we move more rapidly than former generations did. We travel faster; we send messages across the ocean in a few minutes; we transact business of large amounts in a short time; but when we come to our litigations we find the reproach of the law's delays still existing. We have done very little to remedy this great wrong; indeed, it is doubtful whether in this matter we have not gone backward. Lords Kenyon and Ellenborough tried cases at the rate of twenty-five a day. The very last day that Lord Ellenborough sat at Guildhall, when he was laboring under great infirmity and weakness, he tried seventeen defended cases." A trial now of seventeen cases a day, even by an able-bodied judge, would probably alarm the bar and result in an early retirement of the judge (if holding place by election), for the reason that his dispatch of business would lessen the emoluments of the lawyers. But the main concession is that while there is advancement in every other field of human effort, in law alone are we at a standstill, or are retrograding! A few creditable changes in procedures have been introduced after prolonged and tedious opposition, such as that an accused party may testify in his own behalf, or that a wife may testify for or against her husband; but in the main we have the same forms and ceremonies that came into use five centuries or more ago, the same mass of verbiage in legal forms that confuse and perplex, and convey no idea of anything in particular except vacuity. Let a man of ordinary intelligence read a formal indictment for murder, and then ask him to tell what are the ideas expressed, and he can hardly do it with more clearness than if written in Greek or Chaldaic. Take the concluding paragraph of a warranty deed in common use, and we have one hundred and sixty-two words of idiotic verbiage that not one man in a hundred can understand except by hard study and risk of brain-fever, and even lawyers, judges, and conveyancers must judge of it by its conformity to prescribed legal forms rather than through any warrant of title conveyed by it. But though every man not a lawyer abhors such a jumble of words, it remains as part of the machinery by which real estate is transferred, and any proposition in a State Legislature to abolish such a form and substitute something clear, short, and explicit, would call out the active opposition of not only every lawyer in the body—which is usually two thirds of all the members—but also of, substantially, every lawyer and court officer in the State, as well as every legal printer and dealer in legal stationery, for the reason urged by Demetrius in Acts xix, 25, "By this craft we have our wealth." And *this* evidently is the one controlling, all-powerful influence which stands in the way of legal reforms, and will until the people combine and overthrow it.

It is not the law's delays, then, which by any means constitute its one great offense. That is but an incident of a system which needs reform from top to bottom. The lawyer has, seemingly, settled down to the conviction that his "best hold" for a fortune is to oppose radical changes, at least until some substitute as profitable is within reach. He may not be opposed to reforms in the abstract, but a reform that is to cost perhaps thousands a year at first, though it may be of immense benefit to clients, is not to his liking. That is his conservatism. Perhaps morally it is not unlike that of others whose vocations have been abolished through great modern inventions—the use of steam, electricity, etc.—but if so, the peculiar tactics of the legal fraternity have defeated nearly all propositions for legal reforms, and thus justified the statement of Judge Learned already quoted. The lawyers forget that in other callings nothing has been lost in the aggregate to anybody by reforms that facilitate business, as new inventions create new industries requiring a higher grade of intelligence; and that business is always sure to develop in proportion to the facilities for its rapid, safe, and cheap dispatch. None smile sooner than they at the occasional outbreaks, even yet, of ignorant laborers against new inventions, on the ground that such changes drive them to starvation. They know, if laborers do not, that machinery only changes the form and method of industry without abolishing it, and hence it would be well to consider if this principle would not apply also to a reformed system of law procedure which would secure justice speedily instead of defeating it through delays that extend through generations, with little benefit to anybody but lawyers. It certainly prejudices the community against the legal profession, and impels many tempted into litigation to keep aloof, and often to bear their wrongs at great loss rather than risk further losses by employing lawyers who have no interest in any case except to extract fees or reputations from it. But if we had a system of deciding law questions speedily and cheaply it might lead to a greater volume of business, promote the ends of justice far better, and elevate the profession immeasurably in public esteem. Even if the reforms would dispense with one half or two thirds of all the lawyers, and who may be said to be non-producers of public wealth, it would not be a reform that really high-minded and conscientious lawyers need regret. A country like ours should not tolerate any parasitic classes; and, once rid of all the useless lawyers, the reform would make some other classes useful whose presence now is detrimental to the public good.

Let us look at some of the changes for which public sentiment seems ready, and which would certainly be inaugurated soon if a liberal-minded bench and the more honorable members of the bar were to sanction them. They are noted here, not so much in the order of their importance, as in the order in which they come to mind.

First, the jury system. There is wide-spread dissatisfaction with it, especially as to capital cases, or where heavy punishment is involved. In important civil cases where great interests are at stake, it is also regarded very much as a failure, leading nearly as often to the miscarriage of justice as otherwise. The traditions that require unanimous verdicts are antiquated and unworthy of serious consideration. Why should twelve men, totally untrained in the examination of legal questions or evidence, be expected to agree, in the face of a mass of contradictory evidence, and after listening for hours, or even days and weeks, to the arguments of counsel skilled in making the worse appear the better reasoning, and without a scrap of written or printed testimony before them? Two witnesses to the same transaction can rarely agree as to details, and yet a jury of twelve men, some of them very ignorant, are required to agree, or else the case, in all its dreary length and breadth, must be tried again before twelve other men equally unfit, or be abandoned. If they do not agree on the first ballot, they are kept in confinement until the strongest-willed can conquer the rest, or until their natural desire for a discharge impels them to agree, whether the verdict represents their real convictions or not. It is right that, in capital cases at least, there should be a heavy preponderance, but to require unanimity is absurd, and often defeats justice. If eight or nine men out of twelve can agree that a prisoner is guilty, it should be sufficient, especially while all the chances for appeals and pardons remain. Were the verdict a finality, it would be different; but no convicted murderer with money at his command ever thinks of submitting at once to an adverse verdict. The criminal laws seem specially contrived to shield notorious villains from swift punishment; and the "able counsel," no matter what his case, keeps up the fight until every resource for delay or escape is exhausted.

The one vicious principle at the base of litigation, at least in criminal cases, and which overshadows all others, is that the professional advocate is generally oblivious to all the claims of abstract justice, or that there is any obligation resting on him to protect the community. It is his *client* who is to be sustained, right or wrong, and the claims of justice or of the public receive no consideration. He is educated to this idea in the law-school, and, becoming a rule of action, it makes the lawyer, comparatively, a narrow man, and one of the most unfit of all men—of equal education—to trust on questions involving the great interests of society, hence especially unfit to be a law-*maker*. This allegation will surprise some, but it need not when we remember that it is quite as much the lawyer's business to impair or destroy the force of a good law as to sustain it. He labors to find defects in the law, or to boldly mislead courts and juries so as to secure wrong interpretations of law, and thus by assurance and false logic screening his client against its just intent. To make legislators out of such men is poor policy, because ill-digested, obscure, contradictory statutes grind out grists for the lawyers' mills, and the man educated to look out for nobody but himself is reasonably sure not to neglect such an opportunity to promote litigation.

This disposition to thwart justice on occasion suggests another reform. If judges are really "learned in the law," as they should be, why are lawyers needed at all as advocates *pro* or *con* in the trial of ordinary jury cases? Why not make it the business of the judge to examine the witnesses and bring out all the facts? It is the facts as they bear on the case which are wanted, and not that version of them which the paid advocates wish presented. They have no wish and no intention to bring out the truth except as it assists their own side; they desire, indeed, to suppress it when possible, which is their aim in the bullying and browbeating of timid witnesses: hence the judge, who is sworn to impartiality, and has no interest in concealing anything, is a far better man to examine the witnesses. If this would overwork him, let him have assistants, or let the court be composed of several judges. The taking of testimony would then be more rapid, because there would be no lawyers' wordy wrangles to cause delay and weary the jury; and, when concluded, the presiding judge would not, in making his charge, be obliged to warn the jury against a mass of irrelevant testimony. In order to guard against possible errors by the court and secure a review by a higher court on really important points, counsel for each side might be present to watch, take exceptions, and secure a review under certain limitations; but a careful judge would rarely make mistakes that needed review. Besides, appeals or reviews should be greatly limited. Judge Learned, in his article, shows their abuse and evils very clearly, and also points out that they do little toward securing exact justice. "When the end is reached," he says, "it is an end only because it can go no further, and not that the last of a dozen or twenty trials is infallible." The long delays, extending sometimes through several generations, do more to impede justice and bring odium on law and lawyer than any right decision at the final end can neutralize. It has become, in the main, a contest of the longest purse, and that even-handed justice should suppress. And this would have happened long ago but for the lawyers.

The requirements of present laws which authorize the exclusion from juries of persons who may have formed an opinion of the case from newspaper reports is another absurdity. Few well-balanced men would be influenced in a verdict by what they had read or heard before the trial. In some cases it would assist them in the examination of witnesses, for that should be part of the duty of every intelligent juror. What is wanted of a juryman is not original ignorance of the case, but that cast of mind to give a verdict on the evidence presented on the trial—not as presented in the newspapers. To do otherwise is to restrict the choice of jurors to the most ignorant men instead of the most intelligent, and to that are undoubtedly due the many monstrous verdicts which disgrace our jurisprudence. Men who do not think, or read, or study, are exactly the sort of men to be led astray by glib-tongued lawyers, and made to forget the evidence and even to disregard the judge's cool analysis of it. It is difficult enough for twelve men of fair intelligence to reach a unanimous conclusion as trials are conducted; but for twelve ignorant men to do justice is plainly absurd. The fact is recognized among laymen, but lawyers are satisfied and ready to oppose change. The public see the wrong; but while the great majority of thinking people favor a thorough reform, there is in some minds a superstitious fear of attempting anything radical so long as eminent judges or lawyers stand aloof or shake their heads as if it were a sacrilege to uproot those hoary legal abuses and stupidities inherited from the feudal ages. Though bad enough, some of them argue that "we might get something worse," and one journalist goes so far as to claim that we should be satisfied with the legal status because courts of law are better, with all their imperfections, than to settle disputes by arms, as was the course under tribal and barbaric rule!

But besides reforming the jury system by broadening the field of selection and by accepting in many cases a verdict of two thirds or three fourths, it may be reformed also as to certain cases by dispensing with it entirely, at least in its present form. Why not have trained men for jurors as well as for judges? Why is it supposed that twelve men drawn at random, ignorant of law, and unused to weighing evidence, will reach a just decision better than one, three, or five men educated to and experienced in such work? If some sort of training and adaptation are necessary in most other pursuits, why are they not in the difficult work of dispensing justice? In certain cases the decision might very properly be left to the judge, who, if he chooses now, can, to a certain extent, control the jury. But—on account probably of the jealousy of lawyers—the tendency in recent years has been for the court to express no opinion, but to "instruct" the jury in a way to throw them still more on their own resources by pointing out that, *if* they think so-and-so, then their verdict must be so-and-thus; while if they think the evidence warrants a so-and-thus conclusion, then the verdict must be so-and-so! If the court shows a leaning, and charges in accordance, exceptions are taken, and on an appeal a new trial may be granted, usually with an advantage to one side, particularly in criminal cases. Time dims the edge of one witness's memory, while others may die, or run away, or may come into court with revised testimony, and a case very clear if tried early loses much of its clearness and perhaps some of the witnesses five years after date. Lawyers know this, and in desperate cases count always on the gains of delay. It is an outrage on justice which the people privately anathematize. But what can be done against "the majesty of the law" when lawyers wink at and support the rotten system? Even the judges are silent, and when they do speak it is not to denounce the foundation of abuses of the legal profession. In cases where judges hold office for life, one would expect them to be really independent of bar influences, and ready to lead in the great reforms needed. But, having been lawyers before they were judges, it seems too much to expect that they will rise above bar influences, and hence, as we get little aid from them, it will be left for the people themselves to attach as many modern improvements to jurisprudence as mark our advance in other callings.

Many minor abuses can be mentioned which ought to be easily reformed. One very gross one is the forcible detention of innocent witnesses of a crime. A person far from home, and a stranger, can be imprisoned indefinitely to secure the "ends of justice" in case bail can not be given for attendance at the trial. There is no law to take the testimony of such a witness and discharge him, but legal conservatism requires that he shall "confront" the accused in open court. It is right that this should be done when it does not in itself become a punishment of the innocent, but the bearing of a witness in court has no such value as justifies an outrage on his rights. The testimony might be quickly taken *verbatim*, followed by a cross-examination, with notes as to the witness's "bearing," and he then be left to go his way. As to his credibility, that could usually be ascertained at his residence, and his testimony could then be submitted for what it was worth. This would entail little or no hardship on anybody, and generally would promote the ends of justice quite as well as now. Sometimes, as in an instance in New York in 1885, a crime is committed against a respectable woman, and on making complaint against her ravisher she is imprisoned with thieves and prostitutes to insure her presence at the trial, while the miscreant who assailed her, being widely known among politicians and saloon *habitués*, remains at large on bail! Such proceedings subvert or discourage justice, but a reform involves so much disturbance of conservatism that a quarter of a century may elapse before it is favored by lawyers.

Abuses in the examination of witnesses often crop out, which tend to discourage litigation and interfere with justice. A lawyer with a bad case, but ambitious to maintain or make a reputation, is quite certain to make the cross-examination of witnesses a terror to any person whom browbeating or insults can throw off his balance. Judges might reform this, but, as in most other law proceedings, the attorney is allowed a latitude out of all reason. A favorite way to confuse a witness is to insist on categorical answers to questions ingeniously framed to reflect on his consistency, and, when any attempt is made at explanation or qualification, to suppress it by bullying and threats. Any man of much observation knows that "the truth, the whole truth, and nothing but the truth," can not be always told by answering "yes" or "no," and for this reason witnesses have a moral right to explain or qualify; but the average lawyer has no regard for that, if a qualified answer is likely to injure his case. The truth is often the last thing he wants, and if he can confuse, or worry, or bully the witness so as to throw doubts on his testimony, it harmonizes with *his* ideas of "the ends of justice." The courts are censurable for allowing this abuse, and it is a pity that there is no appellate or impeachment court to take special cognizance of such offenses, and to punish both judge and lawyer when such outrages are consummated. In other cases the character of respectable witnesses is outrageously attacked in summing up, and trifling, youthful, almost forgotten indiscretions magnified out of all proportion to their importance in order to throw discredit on testimony which can not otherwise be assailed.

It need not be said that crime is rarely punished in proportion to its seriousness, nor that this matter is almost invariably governed by the amount of capital controlled by the criminal for defense. And yet the legal profession, which on occasion has so much to say of its services and its high character, never treats this as a reproach. Probably not one lawyer in a thousand thinks it disreputable to defend the most infamous swindler, defaulter, or bank-robber for pay, thus sharing with him in the avails of his robberies. The well-known fact that the late William M. Tweed was a robber on a colossal scale did not deter "eminent counsel" from defending him persistently until, owing to some informality, his release was ordered by the highest State court. Nobody questioned his guilt, but the conditions of the law are such that an error which did not affect the question of guilt at all was enough to set aside years of costly litigation, and to liberate a smooth-mannered villain whose incarceration for the rest of his worthless life would not have atoned for his demoralizing career.* And still, what lawyer has been moved by such a defeat of justice as to make any attempt to protect the community against a repetition? Why should any court be empowered to turn loose a notorious robber simply because a single step in the proceedings against him was erroneous though not affecting the question of guilt? A departure from strict rules in election matters is not allowed to affect the result, provided the voter's intent is carried out; and most men of sense will say that technical errors at a trial ought not to vitiate the proceedings, provided no injustice is done. But as long as the lawyer thinks his duty is alone to the client who pays him, and nothing to the public, this debasement of honor and judicial functions will go on.

When a criminal has neither money nor political influence, justice is sometimes swift enough. A New York daily some time ago reported that a common thief, who had snatched a scarf-pin worth a dollar, was "railroaded" through court in a few days and sentenced to five years in the penitentiary, while a saloon-keeper went free who "had been arrested eighteen times in two years on charges of beating, assaulting, and robbing women." But the latter, it was expressly stated, had "political influence," and boasted that he had "a pull" on the courts which would always shield him. Perhaps this was exaggerated; but no observant man can doubt that justice must often fail when the bench is occupied by active associates of leading politicians. The method is not openly to defend and set at liberty, but to rail at and stigmatize witnesses as "informers," to discredit their testimony, make postponements, discharge for alleged informalities, or put over the trial from court to court until public interest is lost, and then to permanently "pigeon-hole" the charges or enter a "*nol. pros.*" This is comparatively easy in communities where certain outlawed immoralities are supported by local public sentiment, such as gambling, lotteries, horse-racing, betting on elections, unlicensed liquor-selling, drunkenness, prostitution, prize-fighting, Sabbath desecration, etc. These can not be made legal, because the State is greater than the city, but local sentiment is usually powerful enough to control the courts, and through them to make the laws a nullity. But with a powerful bar bent on the administration of justice, and not conniving at nor leading in opposition to good laws, this could hardly happen. Hence it is not very wide of the mark to say that lawyers as a class do not take a deep interest in abstract justice, or that they are prominent in agitations for moral reforms. Their training and traditions are against it, perhaps because litigation offers its best rewards in communities where morality and justice are not much recognized—at least until vigilance

* When released from the penitentiary, Tweed was held in bail, to the amount of $3,000,000, in pending civil suits, and, unable to furnish this, was committed to Ludlow Street Jail. A few months later he escaped, but, after hiding about a year, was brought back to the jail, and died there in April, 1878.—Editor.

committees and Judge Lynch supplant the regular courts. That is the natural outcome for any locality where the lawyer, and especially the able criminal lawyer, achieves his highest successes. Lynch law dwarfs immensely the lawyer's importance, and while it is a dangerous remedy for legal evils, it is well to remember that it is best avoided by such an administration of the law as not only gives the criminal a fair chance, but in addition protects society.

It may be charged that a general feeling of hostility to criminal lawyers would make it easy for real criminals to involve the innocent in trouble. This is to be considered; but the history of judicial proceedings in recent years rarely shows that persons leading lives of probity, faithful to every duty of the good citizen, are often arraigned at the bar of justice. In general, under a free government, those charged with great crimes are guilty, and their swift conviction and punishment are demanded by every interest of society. In other cases suspicion may be due to bad habits and bad company, and when this class of people are charged with crimes they have themselves mainly to blame. What is wanted is swift punishment for real transgressors, and that our present system of criminal jurisprudence does not bring. The safeguards provided for the innocent are perverted to the use of the guilty by lawyers who foolishly imagine that their own interests will be promoted through the defeat of justice, forgetful that reactions must come when public interests are persistently disregarded.

A reform of great value to the State would be the education and training of judges at public expense, instead of taking them, as now, from among practicing lawyers. We have a National Military Academy and a National Naval School from which to obtain officers for the army and navy, though only at long intervals and in great emergencies is there any serious need of them; but the administration of justice, which is an every-day need, is left pretty much to chance. The lower courts, those presided over by justices of the peace in the rural districts, as well as the lower grade of city courts, are usually held by petty local politicians, without, generally, any pretense to legal knowledge except such as they obtain from certain printed forms prescribed for them, and whenever an important case is tried by them it is of course appealed. It should be said, however, that in spite of many drawbacks, these petty courts—in the country at least—dispose satisfactorily of a great deal of litigation without a tithe of the cost, delay, and parade of the higher courts, which are invariably presided over by lawyers sitting during regular terms, and where justice is balked at nearly every step by the various arts—impossible for a layman to catalogue—so familiar to lawyers, and with which the judges, from their education and long and close association with lawyers, very earnestly sympathize. If the United States, or each State, had a school for the education of judges in which the course of study, in addition to a knowledge of the principles of law, aimed to fit the pupils to administer justice without much regard to mere technicalities or legal hair-splitting, and which kept in view, first and foremost, that the courts were for the benefit *of the people at large*, and not to furnish a living for lawyers, the gain to justice would be something akin to what modern inventions have given us in contrast with the methods of former generations. From the graduates of these schools our judges should be appointed to serve during good behavior, with promotions regulated according to ability in the discharge of duty, and seniority of service where otherwise there was equality, such considerations to rule as would secure the best service. The details for such a school, and for selections from its alumni, could be readily worked out, but are unnecessary here. The gradations of courts, after the system was once inaugurated, would give the new graduates the necessary experience from the lower courts up, and would bring into the service a class of judges who, owing nothing to the lawyers, would not be influenced by them in any schemes for delaying or defeating justice, or in allowing them enormous fees because great sums were at stake. These judges should take the place of lawyers to a certain extent in examining witnesses, so as to draw out the whole truth and only the truth, instead of only such parts of it as suit the *ex-parte* counselors. As long as the lawyer was an aid to the court he might be tolerated and encouraged, but when he proved an obstruction the mandate of the court should remind him of his true work and keep him in line with it. Such a system would greatly discourage the unscrupulous and "bumptious" lawyer, of course, because it would dwarf his importance; but if justice can be so administered as to do without him, and to turn his talents into more useful channels—for instance, the mechanic arts, agriculture, auctioneering, mining, cattle-driving, etc.—who will complain? Every new invention cripples or overturns some vested interest to promote something better; and if, after centuries of long-suffering and forbearance, the grip of the lawyer class can be shaken off and justice administered with speed, regularity, and exactness, and at a great reduction in cost, it would be a consummation worth other centuries of effort, and be the best token of an advancing civilization.

Another much-needed reform is to sweep away the useless verbiage that now so greatly encumbers law papers and makes them legal terrors. The reader will best appreciate this suggestion by trying to "digest" the clause of a warranty deed following the names of the parties, and which assumes to state the purpose of the document, thus:

"**Witnesseth**, That the said party of the first part, for and in consideration of the sum of —— dollars, lawful money of the United States of America, to us in hand well and truly paid by the said party of the second part, at or before the ensealing and delivery of these presents, the receipt of which is hereby acknowledged, and the said party therewith fully satisfied, contented, and paid, have given, granted, bargained, sold, aliened, released, enfeoffed, conveyed, and confirmed, and by these presents does give, grant, bargain, sell, alien, release, enfeoff, convey, and confirm to the said party of the second part and his heirs and assigns forever: all that certain tract or parcel of land and premises hereinafter particularly described, situate, lying, and being in the township of Snipe, county of Woodcock, and State of Huckleberries, bounded and described as follows, to wit." Here the legal description is inserted with comparative simplicity. One would think when that was ended it would complete the transaction, so that "the party of the first part" could sign the deed, take his money, and go home; but not yet, as two hundred and thirty-two words are then used to say that the purchaser is not only to own the land, but everything on it; that it is for his heirs as well as for himself, "forever"; that the land is unencumbered by debts, and the title "as good as wheat." Then comes the warranty clause already mentioned, containing one hundred and sixty-two words full of sound if not of sense; then the signature of the seller and of his wife, if there be a wife; then the seals, another relic of feudal ages; then the signature of the witnesses, and then a formal acknowledgment before some official whose one pleasurable duty is to exact a fee. The seller is then let off; but the buyer, if he desires his deed secure against thieves, fire, or a second deed of later date, must have all the beautiful rubbish in it recorded by a salaried official deputed for that work, who charges another fee, and keeps the copy in a fireproof building at the cost of the county.

Now, in place of this ingenious and ridiculous piece of legal circumlocution, let us see if something could not be devised which would express the same ideas, and hold all the parties to the contract—something like this:

This deed, made this —— day of ——, in the year A. D. 1887, witnesseth: That I have this day sold to John Smith, of etc., for one thousand dollars, the following described piece of land, with everything on it known as real estate, situated in the town of ——, county of ——, and State of ——, bounded as follows: (Description here inserted.)

And I hereby warrant the purchaser, John Smith, that I am the lawful and only owner of the said land; and also that there are no claims to encumber it; and that his title hereby becomes indisputable.

JOHN DOE.

When two men make a verbal contract involving a horse-trade before reliable witnesses, the courts hold them to it without a scrap of written agreement. When one man gives his note for value received to another, he is held to this agreement if a clear intent is indicated, no matter if the note is bunglingly expressed and half the words misspelled. A man who can not write his own name can still convey away his real estate by affixing "his mark" to his name after somebody else writes it; and a verbal promise, indicated by a nod before some authorized magistrate or clergyman, binds two persons of opposite sexes to each other in marriage for life. All the vast interests of the kingdom of Great Britain are regulated and controlled by an imaginary "constitution"—one never written or printed, but which seems, Topsy-like, to have "growed" out of customs adapted to the hour, and which come to the present generation as traditions, and which are accepted and interpreted by the British courts with as much reverence as though everything had been written out, sanctioned by the people, and filed, as with us. Even British "common law" is nothing more than ancient customs accepted as laws, and interpreted as such with as much care and exactness as though they were statute laws sanctioned by Parliament. All this shows that the mass of verbiage in legal documents has no basis of necessity for its existence when courts administer justice according to certain general principles, and that the excuse for its retention has some other purpose than justice between buyer and seller.

A large part of our litigation is due to laws which embody contradictory or unconstitutional provisions, or are so vaguely expressed that judicial decisions are necessary to their interpretation. In this, too, the "fine work" of the able lawyer is apparent. The inexperienced or non-observing citizen would suppose that a Legislature of lawyers would enact statutes about which there could be no ambiguity and no conflict with higher laws. The lawyer is not slow to express apprehension about the fitness of plain citizens to enact laws, and of the necessity for a legal supervision of embryo statutes, in order that they shall not shock conservatism nor create disorder in the body politic. To every Legislature he goes in force, generally making a majority, and sometimes a two-third majority, carried there in triumph by those brilliant qualities which distinguish his profession, popularly known as "cheek," in addition to wire-pulling and that trinity of political virtues aptly described by a Pennsylvania politician as "addition, division, and silence." In the Legislature his work may be described as that which first and foremost guards on all occasions the interests of "number one." When a proposed law is crude, ill-digested, or of doubtful constitutionality, it never alarms him, because it is such that need interpretation by the courts. Then, again, his constituency may require his support of certain measures which he privately abhors, and to kill or cripple such measures with crude, incongruous, or unconstitutional amendments is usually regarded by him as statesmanship of a high order. A body of men chosen without solicitation of their own, and because of intelligence and high moral character, would scorn such work, but the lawyer regards them generally as "cranks" or "impracticables." A good legislator must be something of a plodder, ready to do a great deal of inconspicuous work. He must watch legislation very closely, particularly the work done in committees, and in each Committee of the Whole. He must see that the various bills are in the public interest—not in the interest of cliques; that they are in harmony with the Constitution; and also that the various sections of each bill are in harmony with each other. This is a sort of drudgery which the new country member, chosen because of conspicuous personal worth, accepts as part of his duty, but which the "smart" lawyer shuns, because *his* mission at the capital is above that of being a "legislative drudge." The time for him to study legal phraseology and the adaptation of laws to their purpose is when he is paid for it. As to legislation in behalf of morals, he has generally no faith in it, his idea being that morals should take care of themselves, or be left to preachers and Sunday-schools.

Public sentiment is ripe for leadership in this reform, and it will come sooner or later, whether lawyers acquiesce or not. Honorable lawyers ought to see that their interests center in the conservation only of what is useful, and not in ignoring or defying public impatience until it finds vent in revolutionary measures. The principle of *the greatest good to the greatest number* is what needs recognition—not protection to a remnant of the feudal ages.

HYPNOTISM IN DISEASE AND CRIME.*

By A. BINET AND C. FÉRÉ.

WHAT we have said of hypnotism, and particularly of suggestion, may lead the reader to understand the virtue of medicine for the imagination, of which the importance has already been intimated by earlier writers. Deslon asked why, if medicine for the imagination was the most effective, it should not be employed.

We must be permitted to dwell for a moment on this medicine for the imagination, which is entitled to the name of suggestive therapeutics. The process is as follows: Influenced by a persistent idea, suggested by external circumstances, a paralysis is developed. The physician makes use of his authority to suggest the idea of an inevitable, incontestable cure, and the paralysis is cured accordingly. This cure, as well as the development of functional disturbance, was directly effected by an idea. An idea may, therefore, be, according to circumstances, a pathogenic and a therapeutic agent. This notion is not new, but, since it was misinterpreted, it has remained unfruitful.

The most important of the organic disturbances produced by an idea is an experiment on vesication, performed by Focachon, a chemist at Charmes. He applied some postage-stamps to the left shoulder of

* Abridged from "Animal Magnetism," by Alfred Binet and Charles Féré. "International Scientific Series," vol. lix. D. Appleton & Co., 1888.

a hypnotized subject, keeping them in their place with some strips of diachylon and a compress; at the same time he suggested to the subject that he had applied a blister. The subject was watched, and when twenty hours had elapsed the dressing, which had remained untouched, was removed. The epidermis to which it had been applied was thickened and dead and of a yellowish-white color, and this region of the skin was puffy and surrounded by an intensely red zone.

It was in 1869 that Russell Reynolds first noted the existence of motor and sensory disturbances, developed under the influence of an idea. The motor disturbance sometimes consists in spasms, in ataxic or incoördinated movements, and more frequently in paralysis which affects the upper limbs. Erb gives to these symptoms the name of imaginative paraplegia.

The type of this paraplegia is afforded by Reynolds's first observation, which concerned a young woman who was affected by paraplegia under the following circumstances: She lived alone with her father, who had undergone a reverse of fortune, and who became paralytic in consequence of protracted anxiety. She supported the household by giving lessons, which involved long walks about the town. Influenced by the fatigue caused by so much walking, it occurred to her that she might herself become paralyzed, and that their situation would then be terrible. Haunted by this idea, she felt a growing weakness in her limbs, and after a while was quite unable to walk. The pathology of the affection was understood by Reynolds, who prescribed a purely moral treatment. He finally convinced his patient that she was able to walk, and in fact she resumed the practice.

Diseases have been termed imaginary, or diseases caused by the imagination, and this confusion of terms has confirmed the confusion of ideas. We have, however, just shown, especially by means of the facts which relate to paralysis by suggestion, that diseases caused by the imagination—that is, produced by a fixed idea—are real diseases, and, at any rate in some cases, display undisputed objective symptoms.

Since the existence of real diseases, produced by means of the imagination, is proved, it is thereby proved that imaginary diseases do not and can not exist; by this we mean purely fictitious diseases, since as soon as the subject has accepted the fixed idea that he is affected by any functional disturbance, such a disturbance is in some degree developed. It should be added that these diseases, produced by means of the imagination, are not merely influenced by a local disturbance; the subject who allows himself to be dominated by this idea of disease must be peculiarly excitable and open to suggestion; he must be endowed with a condition of congenital psychical weakness which is frequently found in conjunction with more or less strongly marked neuropathic manifestations, or with physical malformations. As Lasègue observed, not every one who pleases can be hypochondriac.

This distinction throws light on the therapeutics of diseases produced by means of the imagination, or suggested diseases.

When one of these victims to hypochondria, anæmic and emaciated, who are usually called *malades imaginaires*, has recourse to medicine, on the plea of suffering pain or some other subjective disturbance, he is usually told that it is of no importance, that he is rather fanciful and should think less about his health, and some anodyne is carelessly prescribed. The patient, who is really suffering from the pain he has suggested to himself, feels convinced that his malady is not known, and that nothing can be done for him. The idea that his complaint is incurable becomes intense in proportion to his high opinion of his physician's skill, and thus the patient, who was suffering from the chronic affection suggested by his imagination, often goes away incurable.

Those who undertake miraculous cures act very differently. They do not deny the existence of the disease, but they assert that it may be cured by supernatural power. They act by means of suggestion, and by gradually inculcating the idea that the disease is curable, until the subject accepts it. The cure is sometimes effected by the suggestion, and when it is said to be by saving faith, the expression used is rigorously scientific. These miracles should no longer be denied, but we should understand their genesis and learn to imitate them.

When a believer associates the Deity with his idea of cure, he is accustomed to expect it to be sudden and complete, as the result of a definite religious manifestation; and this, in fact, often occurs. We had a well-known instance at the Salpêtrière, when a woman of the name of Etcheverry was, after her devotions in the month of May, suddenly cured of a hemiplegia and contracture, by which she had been affected for seven years. Only a slight weakness of the side remained, which disappeared in a few days, and which could be explained by the prolonged inaction of the muscles. This may be termed an experimental miracle, since the physicians had prepared for it beforehand, having for a long time previously suggested to the subject that she would be cured when a certain religious ceremony took place, and it is a miracle which explains the numerous cures by the laying-on of hands which are recorded in the Bible. If we do not go further back than the last century, suggestion explains the cures by Greatrakes, the exorcisms by Gassner, Mesmer's successes, and the miracles performed at the tomb of the deacon Paris in the cemetery of Saint Médard; and in our day, in the famous caves on the slopes of the Pyrenees.

The resources of the physician, who does not profess to be a thaumaturgist, are more scanty. When he is consulted by a patient whose disease has a psychical origin, he is unable, unless in some exceptional circumstances, to inspire confidence in remedies which are not more or less gradual, but, whatever they are, he must prescribe with firmness and authority. It is a well-known fact that the hydropathic treatment of some forms of hysteria has afforded more speedy results than other modes of treatment, merely from the fact that suggestion has been employed at the same time. This remark also applies to massage, etc., under analogous circumstances.

We are particularly anxious to call attention to the effect of moral treatment, and to the part taken in it by suggestion. This is no new thing; when the so-called fulminating pills are administered, suggestion is employed in the pilular form, and when pure water is injected under the skin, suggestion takes a hypodermic form. This medicine for the imagination is particularly to be recommended in that category of diseases which are of definite psychical origin.

This is not the place for insisting on the special indications of suggestion in therapeutics. The study just made is enough to show to what extent it may act on motor, sensory, or psychical phenomena, and consequently how it may be usefully employed in the treatment of the dynamic disturbances which are due to the influence of a psychical action, of a moral shock, or even of a peripheral excitement. Its effect can not any longer be disputed. It is, however, still difficult to give a rigorously scientific account of the results obtained, since few observations have as yet been published, and in some of these it is impossible to find an objective characteristic of hypnosis. Others, again, are incomplete, or published by incompetent persons, whose descriptions do not carry with them a conviction of the reality of the morbid state in question. Finally, precisely on account of the nature of its action, which is exclusively exerted on diseases in which there is no definite material lesion, and which are, therefore, purely dynamic, suggestion only cures affections which are capable of spontaneous modification, or which are influenced by various external agents. At present, therefore, it is difficult to establish the real value of this mode of treatment, although less difficult than in the case of many remedies in general use. It can only be said that it is founded on accurate notions of mental physiology, and consequently on a rational basis.

Since the possibility of curing a certain number of nervous diseases by means of hypnotism is established, it can not be disputed that physicians are justified in making use of it, under the same reservation as any other methods of therapeutics. The physician's responsibility is diminished if he has to treat an affection which would not yield to other measures; if he has obtained the consent of his patient and the concurrence of the patient's friends; and, finally, if he can show that he has acted prudently, with due consideration of the danger incurred by the patient, and with proper precautions against these risks.

Since the past history of hypnotism verged upon the marvelous, it had the privilege of exciting the curiosity, not only of learned men but of people in general. Exhibitions with which science had nothing to do made the public acquainted with a certain number of phenomena of which a criminal use might be made, and hypnotic sleep and suggestion have played a part in several judicial dramas. We think it may be profitable to consider this subject, which is indeed entitled to further development.

Somnambulist subjects often display a kind of attraction for the experimenter who has hypnotized them by touching the scalp. As soon as the experimenter has pressed upon the scalp with his hand, or has breathed upon the subject with his mouth, the latter is attracted toward the experimenter; if the experimenter withdraws to a distance, the subject displays uneasiness and discomfort; he sometimes follows the experimenter with a sigh, and can only rest beside him. It is probable that the phenomena of electivity have their origin in the experimenter's contact with his subject. Bain, in his work on the emotions, remarks that animal contact and the pleasure of an embrace are the beginning and end of all the tender emotions.

The dangers of this attraction with respect to morality were pointed out in the secret report presented to the King of France in 1784, by a commission which had been appointed to investigate the practice of magnetism by Deslon, Mesmer's chief pupil. The following is extracted from this report:

> Women are always magnetized by men; the established relations are doubtless those of a patient to the physician, but this physician is a man, and whatever the illness may be, it does not deprive us of our sex, it does not entirely withdraw us from the power of the other sex; illness may weaken impressions without destroying them. Moreover, most of the women who present themselves to be magnetized are not really ill; many come out of idleness, or for amusement; others, if not perfectly well, retain their freshness and their force, their senses are unimpaired, and they have all the sensitiveness of youth; their charms are such as to affect the physician, and their health is such as to make them liable to be affected by him, so that the danger is reciprocal. The long-continued proximity, the necessary contact, the communication of individual heat, the interchange of looks, are ways and means by which it is well known that nature ever effects the communication of the sensations and the affections.
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> The magnetic treatment must necessarily be dangerous to morality. While proposing to cure diseases which require prolonged treatment, pleasing and precious emotions are excited—emotions to which we look back with regret and seek to revive, since they possess a natural charm for us, and contribute to our physical happiness. But morally they must be condemned, and they are the more dangerous as it becomes more easy for them to become habitual. A condition into which a woman enters in public, amid other women who apparently have the same experience, does not seem to offer any danger; she continues in it, she returns to it, and discovers her peril when it is too late. Strong women flee from this danger when they find themselves exposed to it; the morals and health of the weak may be impaired.

It is possible to suggest to a subject in a state of somnambulism fixed ideas, irresistible impulses, which he will obey on awaking with mathematical precision. The subject may be induced to write down promises, recognitions of debt, admissions and confessions, by which he may be grievously wronged. If arms are given to him, he may also be induced to commit any crime which is prompted by the experimenter. We could cite several acts, to say the least unseemly, committed by hysterical patients, which were crimes in miniature, performed by an unconscious subject, and instigated by one who was really guilty, and who remained unknown. At the Salpêtrière a paper-knife has often been placed in the hands of an hypnotic subject, who is told that it is a dagger, with which she is ordered to murder one of the persons present. On awaking, the patient hovers round her victim, and suddenly strikes him with such violence that I think it well to refrain from such experiments. It has also been suggested to the subject to steal various objects, such as photographs, etc.

To give an idea of the mathematical precision with which the suggested act is executed on awaking, one of the present writers performed the following experiment: We showed to the somnambulist an imaginary spot on a smooth surface, which we could only afterward ascertain by means of careful measurement, and we ordered her to stick a penknife into this spot when she awoke. She executed the order without hesitation and with absolute correctness: a criminal act would have been as punctually executed.

It is interesting to ascertain whether the subject who is actuated by an irresistible impulse behaves like an automaton subsisting on a basis of the past, on his memory and habits, or if, on the contrary, the subject is capable of reflection and of reasoning like a normal individual. This latter is more frequently the case. When care is taken to suggest a somewhat complex act, for the performance of which some combination is necessary, we may observe that the subject invents such combined expedients although they had not been suggested to him, and this inventive process shows that everything is not explained by comparing him to an automaton. For instance, it was suggested to a subject that she should poison X—— with a glass of pure water which was said to contain poison. The suggestion did not indicate in what way the crime was to be committed. The subject offered the glass to X——, and invited him to drink by saying, "Is it not a hot day?" (It was in summer.) We ordered another subject to steal a pocket-handkerchief from one of the persons present. The subject was hardly awake when she feigned dizziness, and staggering toward X——, she fell against him and hastily snatched his handkerchief. When a similar theft was suggested to a third subject, she approached X——, and abruptly asked him what he had on his hand. While X——, somewhat startled, looked at his hand, his handkerchief disappeared.

These facts show that the hypnotic subject may become the instrument of a terrible crime, the more terrible since, immediately after the act is accomplished, all may be forgotten—the crime, the impulse, and its instigator.

Some of the more dangerous characteristics of these suggested acts should be noted. These impulses may give rise to crimes or offenses of which the nature is infinitely varied, but which retain the almost constant character of a conscious, irresistible impulse; that is, although the subject is quite himself, and conscious of his identity, he can not resist the force which impels him to perform an act which he would under other circumstances condemn. Hurried on by this irresistible force, the subject feels none of the doubts and hesitations of a criminal who acts spontaneously; he behaves with a tranquillity and security which would in such a case insure the success of his crime. Some of our subjects are aware of the power of suggestion, and, when absolutely resolved to commit an act for which they fear that their courage or audacity may fail when the moment arrives, they take the precaution of receiving the suggestion from their companions.

The danger of these criminal suggestions is increased by the fact that, at the will of the experimenter, the act may be accomplished several hours, and even several days, after the date of suggestion. Facts of this kind, which were first reported by Richet, are not exceptional, and have been repeatedly observed by us.

The reality of this class of facts can not now be disputed, but the difficulty of proof in any given case is considerable. We have not, in the case of impulsive acts, the same objective criterion as we have in hallucinations and in the paralysis of movements and of sensation. It is, therefore, necessary for the expert to be cautious in his judgment.

Loss of memory is one chief characteristic of the facts of suggestion. The hypnotic subject does not know from whom, when, and how the suggestion was received. This amnesia may be either spontaneous or suggested, and it is a phenomenon of the waking state, which disappears when the subject is hypnotized anew. The recollection of all which occurred during hypnosis is then revived, and the subject is able to indicate, often with remarkable precision, the author of the suggestion, the place, day, and hour when it was made to him, always supposing that he has received no special suggestion of complete oblivion. Hence the question occurs whether an accused person who appeals to an hypnotic suggestion for his defense, and who submits to experiment, can be profitably examined at a time when he displays all the physical characteristics peculiar to the somnambulist state, so that there is no danger of imposture. We have had occasion to show that some subjects are in this state capable of suppressing the truth, and Pitres has shown that deceit was not impossible. An hypnotic subject may at the same time be criminal, and suggestion must be accepted only so far as it admits of material proof, or at any rate as far as it can be necessarily deduced from the facts of the case.

Dr. Schunk, in the British Association, prognosticating the future of chemistry, thought that pure or systematic chemistry becoming practically exhausted in the course of time from the want of new compounds to prepare, the future fields of the science would lie in such lines as the growth-processes of plant-substances and of those agents to which decomposition and decay are due.

CALIFORNIAN DRY-WINTER FLOWERS.

By Professor BYRON D. HALSTED.

THE writer spent three months of the winter of 1886-'87 in and around the cities of Los Angeles and Santa Barbara in Southern California. The previous summer had been no exception to the rule, and the whole country received no rain from the last of April until the close of the year. In fact, the long-expected rains did not come until the middle of February, and we left in the midst of the raging floods. The wild plants, therefore, which were in bloom from December until February, had not felt the invigorating influences of water from the clouds for nearly ten months.

It is the purpose of this paper to call attention to the winter-blooming plants found upon the highlands, or at least not growing along the streams or within easy reach of water coming from any natural springs or other perennial sources of moisture. The roadways, for example, during the winter, were deep with dust, and every passing breeze carried the impalpable powder in a fine cloud over all surrounding objects.

The first plant bearing blossoms that attracted our attention was the western bindweed (*Convolvulus occidentalis*, Gray). This perennial, twining herb seemed to flourish in the driest earth, and hung out its white or purplish flowers to catch the dust as well as the winter sunshine. Unlike its first cousin, the common morning-glory, as we see it in the East, this wild convolvulus keeps its flowers open the whole day through, and, for aught we know, for several days in succession. This would only be in keeping with other living things in that quiet, lazy climate, where there is no real winter, or the activity exhibited among plants in localities where they must prepare for impending frosts. A very common species in flower was *Galium angustifolium*, Nutt. This is one of the larger "bed-straws," and may be found in almost any thicket climbing to the height of three or more feet over the dusty and leafless branches of the surrounding shrubbery. The flowers are very small and inconspicuous, but are present in large numbers. The fact that this is one of the polygamo-diœcious species adds interest to it. Botanists have puzzled over it to some extent on account of there being male and female plants, which differ somewhat in general appearance. Upon this species it was interesting to observe the long, slender, and apparently lifeless stems from which sprang at frequent intervals the green, leaf-bearing branches with their large clusters of small flowers. There was an adaptation to circumstances, and young shoots were developed where they would do the most good. One species of the "painted cup" (*Castilleia parviflora*, Bon.) was occasionally met with in the open grounds, but it looked the worse for its winter's wear. This species is covered with a villous pubescence, and this with the accumulation of dust rendered the inflorescence far from a brightly "painted cup." The flowers are, however, not small, as the specific term would suggest. They are well-nigh as large as those of *C. coccinia*, Spr., of the Middle States. Another member of the same family is the *Scrophularia Californica*, Cham., or California figwort. This was not abundant, and might be easily mistaken for the Linnæan species *S. nodosa*, L., of Europe and the Atlantic States. The western species may, however, be distinguished by the coarsely, doubly incised, or sometimes laciniated leaves, and by the sterile stamens being spatulate or pointed near the apex. Like the eastern species, this is a fine illustration of proterogyny in flowers fertilized by means of insects. The pistil first appears upon the lower lip of the flower. After the style has become flabby and reclined upon the corolla, the four stamens take its former place and shed their pollen upon the bodies of nectar-seeking insects.

A "four-o'clock," one of the three species within the Golden State, namely, *Mirabilis Californica*, Gray, was found, with its viscid pubescent, thickish, almost sessile leaves coated with dust, while the small rose-purple flowers were in striking contrast with their surroundings. We found this one of the most difficult of all species to prepare for the herbarium. After weeks of drying, the viscid covering would still remain. At least two species of nettles were found in bloom, but as far as showiness goes they might as well have been in fruit! Around Los Angeles there is a very coarse, tall species (*Urtica Breweri*, Wat.), which reaches above a person's head, and is loaded with the green panicles of flowers. The leaves are frequently six inches long and finely pubescent. The stems are hispid, and the stinging hairs produce a burning sensation upon the flesh that is akin to numbness, which lasts for several days. One of the ancient natives, observing the writer among these much-dreaded plants, volunteered the information that they were worthless and much to be avoided. He could see no reason why any one would deliberately handle such vile things. The small, slender, stinging nettle of Europe (*Urtica urens* L.) was also in bloom.

Among the *Compositæ* we note *Centaurea militensis*, L., or star-thistle, with its heads armed with a spinose involucre, which includes the pink flowers. This is one of the miserable weeds of waste places that has effected an entrance from the Old World. The *Gnaphalium margaritaceum* of Linnæus, now placed in the genus *Anaphalis*, D. C., with its white, woolly, leafy stems, and pearly, scaly involucres, was frequently met with, and sustained its old-time reputation for being one of the beautiful "everlastings." The most showy of all the herbaceous composites was the *Solidago Californica*, Nutt., which is a strict-stemmed plant, about three feet high, with lanceolate entire leaves, and a pyramidal panicle of racemose heads of yellow flowers. This is the Californian representative of *S. nemoralis*, Ait. The golden-rods on the Pacific coast are few in number, less than one tenth of the United States species being represented in California. The most striking composite is the *Senecio scandens*, L., or German ivy, which in many places has escaped from cultivation and grows rampant in the low grounds, where it climbs to the tops of medium-sized trees, and embowers them in a perfect profusion of bright-yellow blossoms. A few specimens of a helianthus, probably *H. Californicus*, D. C., were found, but a dry winter is not favorable for the sunflowers, especially the annual sorts.

Only one species of the *Cucurbitaceæ* was in bloom—namely, *Megarrhiza Californica*, Torr. This was running over the dry soil like an aristocratic cucumber-vine, with its white male flowers in slender racemes, while here and there a forming fruit exhibited its green covering of sharp, stout spines. We were anxious to secure some of the large seeds to illustrate the remarkable manner in which the cotyledons find their way to the surface of the soil in germination, but were unsuccessful. This "big root," as its generic term indicates, is probably able to obtain more moisture than most other plants growing in similar situations, and which do not strike their roots so deeply into the soil or utilize them as storehouses for accumulated nourishment. This megarrhiza is exceedingly provident, and is, therefore, able to grow where shallow plants succumb to the drought. In the same soil flourished the *Lupinus rivularis*, Doug., and the Californian peony (*Pæonia Breweri*, Doug.). The lupine is a short-stemmed plant, bearing large, palmately compound leaves of seven to ten leaflets, and terminating in a raceme often two feet long, bearing a large number of beautiful purple flowers. The peony is a ternately compound-leaved perennial, with but a few large blossoms, which assert at sight the close alliance of this species with the peonies of the garden. These last three species were objects of rejoicing as the eye wandered over the otherwise almost flowerless tracts in the broad, bowlder-scattered cañon. Not far from the above locality it was a surprise to run upon *Nicotiana tabacum*, L., our common tobacco, growing wild and in full bloom. These plants had escaped from some Mexican garden, or perhaps the old garden had escaped from the slack and profitless culture of the Mexican.

The species that seemed the most at home of all the dust-bloomers was the old vervain (*Verbena officinalis*, L.) of Europe. This species grows in nearly all parts of the globe, and is very likely naturalized in many countries, including California. From out of the heavy covering of dust which is held by the minute pubescence, the purple corollas are spread along the lengthy spikes. Nearly all of the specimens have the older spikes much swollen and otherwise distorted by infesting insects.

Phacelia is a large genus in California, numbering thirty-five species. A few of these members of the order *Hydrophyllaceæ* were in bloom, among which the *P. ramosissima*, Doug., was the most common. It would seem as if earth could not get too dry for this straggling, hispid, or glandular-viscid plant to thrive. The variety *hispida*, Gray, was the most common form at Santa Barbara, and is a very unpleasant thing to handle. A large quantity of the pinnately divided leaves and prickly stems was gathered, as they were much infested by a cluster-cup (*Æcidium*) fungus. At least one species of *Cuscuta* was collected, viz., *C. Californica*, Choisy; but, as all the dodders are parasitic, it is not strange to find them flourishing even while their hosts were leafless and being robbed, so to speak, in their sleep. The species is quite variable, and the extreme forms have been defined under var. *breviflora* and var. *longiloba;* both by Dr. Engelmann, the great and almost life-long student of these sickly parasites.

The dry earth in old stubble-ground was in some places found entirely covered with a carpet of *Calendrinia Menziesii*, Hook., a fleshy-leaved acaulescent plant of the purslane family, and in habit not unlike its cousin, the obese purslane (*Portulaca oleracea*, L.), so frequently spreading over eastern fields and gardens with its low, fleshy stems and leaves. Both seem equally well adapted for thriving in hot and dry places. A downy mildew (*Peronospora*) was, however, making inroads upon this calendrinia, although not, perhaps, as fatal in its work as to *Claytonia perfoliata*, Down. These two hosts are in adjoining genera, and the peronospora seems to be the same in both cases. The claytonia was in flower, but as this "spring beauty" only thrives in moist places, it does not come within the province of this paper. Occasionally a flower of the popular forage plant of the foothills, the alfileria, or "pin-grass," was seen, but only when there was some chance for moisture. This low, leafy crane's-bill (*Erodium cicutarium*, L., Her.) grows rapidly when the rains come and clothes the pastures and foot-hills with a rich carpet of green, followed by a profusion of flowers, unless the cattle and sheep keep it closely cropped.

As a transition to the woody plants, mention may be made of a variety of black nightshade (*Solanum nigrum*, var. *Douglasii*, Gray) which grows abundantly in all parts of the country. It is, perhaps, most at home along the streams or upon the lower areas, but it may be seen almost everywhere, forming clumps six feet high, and shrubby at the base. It can usually be found bearing blossoms and fruit in all stages of development, and is one of the coarser weeds that is quite sure to find its way into cultivated ground and become thoroughly established if sufficient time is given it. Much more attractive than the above is *Solanum umbelliferum*, Esch., which forms long, straggling, tomentose stems, that climb over surrounding shrubbery and peep out here and there with small clusters of large, yellow-throated, blue flowers. This forms one of the cheerful surprises as a person pushes his way through the dust-laden underbrush. In the same localities the flower-hunter will encounter tangling masses of a poison-ivy (*Rhus diversiloba*, T. and G.), called by the natives "yeara" or "poison-oak." The vines grow rapidly, and the shining, newly-developed leaves are in striking contrast with the dust-begrimed stems and foliage over which the treacherous and baneful vines climb. The "poison-oak" differs from the poison-sumac of the East (*Rhus toxicodendron*, L.), in having sharply-toothed leaflets, nearly sessile panicles, and close clusters of fruit. The writer has been poisoned by both species, and can testify that the sensations of burning and itching of skin of face and fingers are practically the same for both kinds. The leaves of a common composite called "gum-plant" (*Grindelia*) are bruised and rubbed over any exposed part of the skin as a preventive.

The most attractive flowers, both as to appearance and fragrance, were those of the phlox-like *Gilia Californica*, Benth. This shrub is two or three feet high, and grows upon the dry hill-sides. The leaves are thickly set and villous, while the stems are terminated by clusters of rose- or lilac-colored flowers an inch or more across the limb. The fragrance is indescribably rich, when not too profuse. The peculiar foliage and the extreme delicacy of tint and fragrance of the flowers place this "mountain pink" at the head of the list of flowering plants during a winter drought. Not far below the Gilia in attractiveness is a member of the large genus *Hosackia* (*H. glabra*, Torr.), of the order *Leguminosæ*. This species has slender, woody stems several feet in length, which bend and become decumbent or rest upon surrounding shrubs. In color the flowers are a mixture of yellow and brown, closely set upon the curved, drooping stems, and are not obscured by the small leaves. The sprays might well serve for making delicate wreaths. This is one of the most common winter-bloomers of the pea family. In the same localities the large vetch *Lathyrus vestitus*, Nutt., with its rose or violet flowers, was frequently found making an entangled mass of wiry stems several feet in length. It seemed most at home along the rocky sides of cañons, where it could climb to its heart's content.

The wild blackberry (*Rubus ursinus*, C. and S.) was abundantly in bloom from the lateral branches upon the long canes. There is an absence of any compactness of growth; the main stems trail along for twenty feet, perhaps. The almost impenetrable entanglement made by such a growth, when climbing over and among shrubs, may be more easily experienced than imagined. Two of the shrubby composites were found in bloom—namely, *Baccharis pilularis*, D. C., and *B. viminea*, D. C. Both species grow much higher than a man's head, and sometimes the stems attain two or three inches in diameter. Both are badly infested with *Coleosporium baccharidis*, C. and H.—a rust which attacks all parts of the plant and causes large swellings in the older stems. This is one of the best illustrations of the perennial nature of some of the parasitic fungi when the host is under favorable conditions for indefinite continuous growth.

The *Ribes speciosum*, Pursh., is an attractive, fuchsia-like gooseberry, and quite distinct from all other *Ribes*. As the branches hang loaded with the clusters of drooping flowers, like beautiful ear-pendants of rich hues, this is one of the most striking sights among the dust-laden vegetation. No one is, however, much inclined to gather quantities of the canes for home decoration, because they are generously provided with prickles, which stand guard upon all sides, and effectively keep away whatever would bring harm. *Sambucus glauca*, Nutt., is the elderberry of California. It grows less like a shrub and more like a tree than our old *S. Canadensis*, L., and the leaves are of a firmer texture. The greenish-white flowers are in large, flat-topped cymes.

The California lilac (*Ceanothus thyrsiflora*, Esch.) is a showy winter-bloomer, and well merits the attention it receives as an ornamental shrub. The plant attains a height of ten to fifteen feet, and the large lead- or lilac-colored flower-clusters appear before the leaves. These are frequently gathered in abundance by tourists for showy bouquets. *Rhamnus Californica*, Esch., of the same order, was loaded with its inconspicuous flowers. A wild prunus was in full bloom, and reminded the writer of spring days in the Atlantic States. The leaves and fruit were not at hand, and the species was not therefore determinable. The mountain-laurel, or "spice-tree" (*Umbellularia Californica*, Nutt.), is the only representative of the olive family in the section visited. This is symmetrical in form, with thick, shining leaves. The flowers are borne in clusters, apparently at the ends of the straight branches. All parts of the tree are pervaded with a disagreeable odor, which becomes quite intense when the fresh foliage is broken, and it may excite sneezing in extreme cases.

Among forest trees, we saw the young bolls hanging from the recently clothed branches of the *Platanus racemosa*, Nutt., or sycamore. This tree, along with the live-oak (*Quercus agrifolia*, Nees), is common in the cañons, reaches a large size, and assumes picturesque forms and positions. The small male catkins were hanging from the short ultimate branches of the live-oak. *Alnus rhombifolia*, Nutt., was opening its gummy inflorescence, while the willows were arrayed in their delicate "pussies."

When we come to the introduced ligneous plants of the city roadside or plaza, where no water is supplied by irrigation, we find the blue gum (*Eucalyptus globulus*), from Australia, the most showy of the trees. These began to flower in Los Angeles by the 20th of January, and a month later those in Santa Barbara were so loaded with the large, top-shaped disks and their whorls of long, white, feathery stamens as to change the somber complexion of the tall, sparsely branched trees. The bees were sometimes so numerous in these trees as to remind one of an eastern basswood during honey-harvest. The pepper-tree, with its drooping, graceful, fern-like tops, seems to be always in flower. On the same plant may be seen all stages, from the small flower-buds to the ripe, rose-colored berries. This very popular shade-tree belongs with the sumacs and poison-ivy, and is pervaded with a bitter, milky juice. Various species of acacias were in bloom. Good specimens of phyllodia were obtained from these trees, loaded with their small spheres of fine flowers.

The orange, lemon, and lime, in the genus *Citrus*, are all examples of plants that may have flowers and ripe fruit at the same time. This is most frequently true of the lime, next of the lemon, and least of the orange. However, it was not difficult to find orange-trees as early as December bearing a ripening crop of fruit intermingled with sprays of the famous fragrant flowers. The most impressive floral display was in the almond-orchards, where, rising from the dry, cleanly-kept soil, there were thousands of peach-like trees in straight rows, still without leaves, but in full bloom. The whole area was one vast sea of pink or peach-color, and the January air was full of the humming bees and lazy butterflies which were here finding so much to eat that life seemed almost a burden to them. As with some other species then in bloom, the almond-trees had been encouraged by the dry, warm winter, and had blossomed earlier than usual. This is a dangerous event, for, should the subsequent weather be cold and wet, the fruits blight, and the crop is much injured.

The leading winter-flowering ornamental shrubs are the roses, of which enough in praise can not be said. The heliotropes have a wealth of bloom, and a fragrance that scents the whole air. Geraniums (*Pelargoniums*) cover the sides of houses, and display a blaze of scarlet flowers. When water is supplied, the whole list of garden-flowers may be obtained in midwinter. A circle of callas around a fountain or water-tank, with spathes a foot across and as white as newly fallen snow, was no uncommon sight. But this paper deals only with the plants that grow without irrigation and bloom from the dust.

We remained long enough after the first rains fell to see the foot-hills begin to grow green, and were confidently informed that in a short time the warm days would quicken all vegetation into new life, and, in place of a few straggling plants, the whole face of the country would be covered with a variety of flowers more to be associated with fairy-land than anything on earth. However this may be, there are enough species which do not give up the struggle upon the approach of drought, so that, if a person is really bent upon finding blossoms, he may succeed, even though he wade through dust to get them.

The Bishop of Bedford lately said, in a sermon, of evolution, that we had read our Bibles wrongly before, and may be reading them wrongly now; and protested against a hasty denunciation of what might be proved to have at least some elements of truth in it, and against a contemptuous rejection of theories that we might some day accept freely and as not inconsistent with God's Word.

THE FAMILY-LIFE OF FISHES.

By KARL HENNINGS.

AMONG the nest-building fishes which inhabit German waters, the most interesting is the tiny "stickleback," whose life-history has been carefully studied. The home of this little animal is sometimes found in ditches, hanging among branches and twigs of plants; the nest is about the size of the average hand, and in structure and material bears a marked resemblance to the round nest of the titmouse. It is a peculiar and remarkable fact that among the sticklebacks the hatching is done by the male and not by the female fish. The building of the nest, a task to which the male also attends, is an interesting event. For many days in succession the little animal, whose energy and perseverance are truly worthy of admiration, collects its material, which consists of loose stalks, plant-shreds, root-fibers, and grass. These it assorts carefully, discarding all material that proves too light. It often drags along pieces exceeding its body in length, and sometimes with great exertion strips growing plants. All this material is worked up into a tangled mass, and layers of sand are scattered in between. The nest is rendered firm by a glue-like juice, which the little mason excretes after the completion of each layer, gliding slowly over the structure; this causes the separate parts of the nest to adhere closely together. The whole, when completed, has the appearance of a sand-hill, and is detected with much difficulty. While at work the fish rarely partakes of any food; it seems that during this blissful period of its existence it finds no pleasure in such every-day events; but with intense animosity it drives back any jealous rivals, larvæ, salamanders, or water-bugs, which cross its path, sometimes with evil sometimes with harmless intentions. After the troublesome hatching-time is over, the anxious papa still continues to care for his numerous offspring; by day and by night he watches over them, and drives away all creatures whose approach seems dangerous. This unremitting watchfulness ceases only when his young are able to raise their weapons of defense and have become somewhat acquainted with their surroundings. Any inquisitive little one venturing too far away is quickly sent home, and it actually happens that those who are very disobedient are imprisoned in the nest. The home-life of these little animals really presents an abundance of interesting and touching traits.

To study the family of fishes which inhabit the ocean and sea-gulfs is naturally more difficult, and rarely proves as successful as observation extended to the inhabitants of our fresh-water lakes, rivers, and streams; but, by the co-operation of naturalists, fishermen, and sailors, many events happening in the deep seas have been observed that afford a further insight into the life and the habits of fishes. In former times fishes were considered mute, impassive, and possessed of but little intelligence; nowadays we know that in these respects they can claim to rank as equals with many inhabitants of *terra firma*. A case in view is the *Cyclopterus lumpus*. This fish shows a decided attachment to its young, and is often seen with numerous little ones, of which it takes the best possible care. It is found chiefly near England's

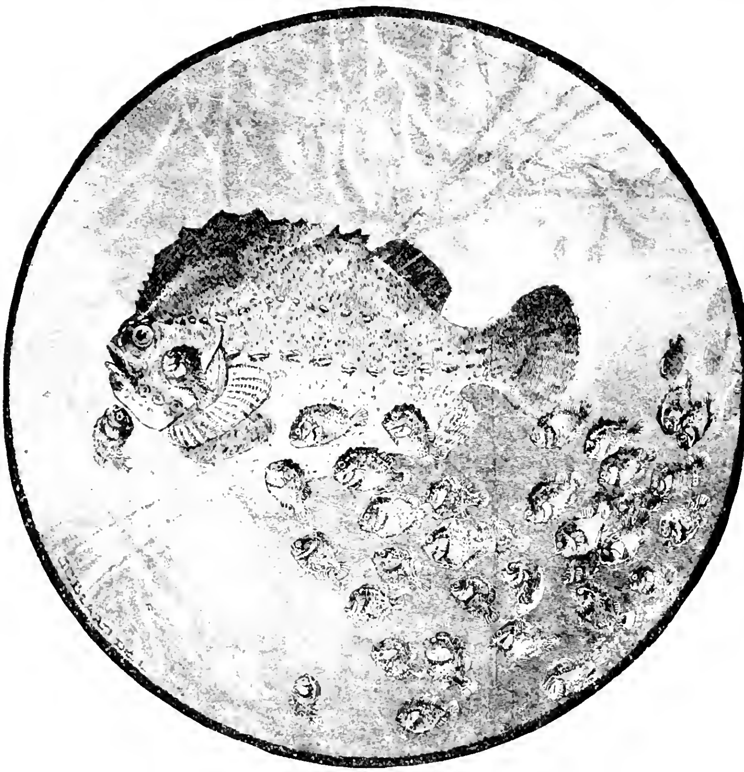

FIG. 1.—*Cyclopterus lumpus*, THE LUMPFISH, WITH ITS YOUNG.

shores, and along the coast of Maine in America. The Cyclopterus has a peculiar form; its body displays many spots, swellings, and lumps which are partially arranged in regular order. It is, generally speaking, not a dangerous creature, never doing harm to any of its fellow-fish. It is defenseless and harmless, and on account of its unwieldy shape moves awkwardly and comparatively slowly. The only weapon this animal really possesses is its extreme ugliness, its uncouth form, which frightens its enemies and not infrequently scares them away. The young of the Cyclopterus follow their mother as little chicks are wont to follow a hen; they play and frolic about her, and are as obedient as little chicks are to the call of their mother. In case any strange object drifts nigh, or an enemy approaches, the whole company, consisting often of several hundred little beings, crowd closely up to their protector. As already said, the Cyclopterus is but a poor swimmer, and it seems but natural to suppose that large waves should threaten danger, and that heavy breakers could easily hurl it on shore. But kind Nature has taken precautions. This curious inhabitant of the sea is capable of adhering so firmly to any object, rocks, drift-wood, or marine plants, that the most powerful waves can not tear it from its support. Its numerous slimy fins can be made to serve as a suction apparatus, so that its body, when thus fastened to a stone, appears like a ship riding at anchor. The Cyclopterus attains a length of about sixty centimetres, and varies in weight from three to four kilogrammes, sometimes even attaining a weight of six to seven kilogrammes. It can change its color from a yellow or a gray to black. Its progeny is remarkably numerous. Sometimes it is found in the Baltic Sea, but is seldom caught, on account of its peculiar mode of living. The adhesion of its body to the objects to which it has become fastened is so firm that a force of thirty-six kilogrammes is required to tear from its hold a Cyclopterus of about twenty centimetres in length. It has also been observed that this fish remains in one and the same place for weeks together, waiting until its food, which consists of sea-nettles and the smallest of fish, has come within convenient reach. Similar to the stickleback, the Cyclopterus faithfully guards its eggs, which always number hundreds of thousands, and proves very courageous in attacking dangerous enemies and heroically shielding its young. The male fish covers the eggs with his body, and retains this position until the little ones have made their appearance. These fishes are seldom taken by man ; in Greenland and Iceland they are sometimes caught in nets, and when found among sea-plants they are speared with a prong-shaped iron. Their worst enemy is the seal, who seems to find them palatable food, although they must be skinned before they can be eaten.

Some species of *Ophiocephalus* present interesting features in their home-life. One variety which inhabits the Sea of Galilee, in Palestine, is known to seek shallow water during breeding-time. The parent fishes fasten small pieces of grass, leaves, sea-weeds, parts of shells, and small particles of wood, to a rock, or to the roots of an old tree, and weave the whole mass into an oval-shaped nest for their young ; they arrange the stalks of grass so as to form a net-like cover, and then fill in the interstices with mud, taking care, however, to leave several openings. At the lower end they place an attachment, generally egg- or pear-shaped, which serves as a sort of cradle, being rocked to and fro by the swell of the waters. The eggs are deposited in the center, and stick to the grass and side-walls of the structure. After the lapse of but a short space of time the nest becomes crowded with tiny beings, which seem anxious to be set at liberty, but are carefully guarded by father and mother until they are capable of taking care of themselves and facing the vicissitudes of life. Mutual attachment among the different members belonging to a family of this species seems to be a marked trait; it has often been observed that they protect their young by harboring them in their mouth whenever danger threatens. Even among the larger salt-water fishes, this manner of sheltering the brood is occasionally adopted. As an example may be cited a fish which the Chinese call *lau-lau*. It attains a length of

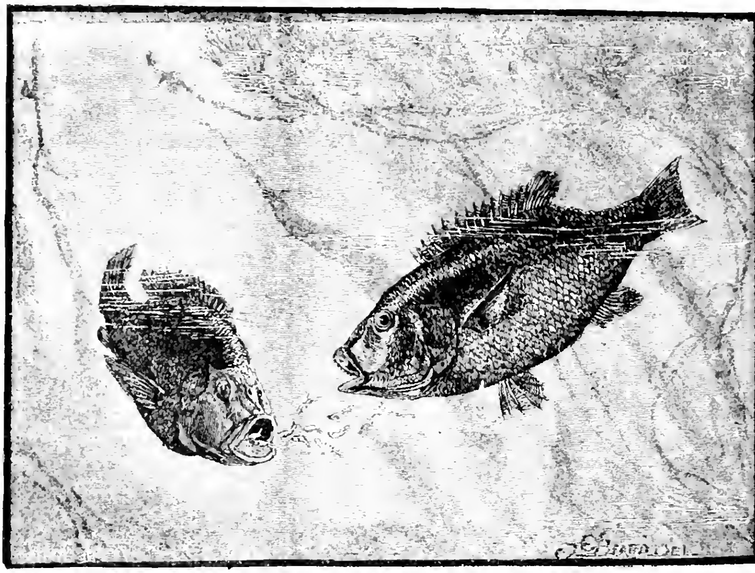

Fig. 2.—The *Ophiocephalus* and its Brood.

thirteen feet and weighs over two hundred pounds. The same observation has been made with fishes whose home is in the lagoons of South America. The young fishes seem so accustomed to this place of refuge that, on perceiving any commotion in the water that seems in the least suspicious, they hasten *en masse* into the protecting mouth of their mother. Another fish, living near the coasts of South America, is known to fasten its young ones to its fins and body by means of a glue-like substance. This gives to these fishes the appearance of being covered with small protuberances.

On the coast of Guiana fishes have been found which dig their nests in miry shores, and live there much as sand-swallows do on land.

Another variety of the above-mentioned *Ophiocephalus*, a native of India, also makes its home in holes in the ground, and can remain in its nest for some time, even after the water has receded. These generally live together in couples. If the earth becomes too dry, they leave their houses and creep along for quite a distance on the damp ground. The lower classes of natives, whenever they see them engaged in such pilgrimages, believe them to have fallen from the sky.

Indian jugglers often keep these fishes in order to let them crawl about on land, and have the people enjoy the wonderful spectacle. Another fish, living in the Gulf of Panama, resembles the kangaroo, inasmuch as it possesses a bag-like receptacle in which it bears its eggs.

The most peculiar, however, of all fishes is the sea-horse (*Hippocampus*), remarkable on account of its queer shape as well as on account of its strange homestead and habits of life. With their numerous joints and their circular tail, these fishes have more the appearance of a plant than of an animal. While swimming they keep in an upright position, holding their tail in readiness for the peculiar use to which they put it. Very quickly they coil it around sea-weeds, and then carefully watch the surrounding water, on the lookout for booty, which, when perceived, they pursue with great dispatch. It sometimes happens that, when two of these fishes meet, they encircle each other with their tails, and they often have a hard time of it before they can again separate. By the peculiar growth of a part of the epidermis on the sea-horse a perfect pocket is formed, in which their eggs are allowed to develop.

Fig. 3.—The *Hippocampus* and its Family.

Yet another kind of fish possesses a form still more weird, and may, on account of its shape and color, be easily mistaken for floating seaweeds. And in this peculiar resemblance lies its greatest safeguard. In like manner the sea-needle greatly resembles the sea-plants among which it lives, not only in form, but also in color, which it can easily change from a gray or brown to a bluish or greenish hue.—*Translated for the Popular Science Monthly from Daheim.*

The report of the British Royal Commission of 1886, on the depression of trade, while it failed to find any single positive cause or sovereign remedy for the stringency of the situation, presented overwhelming evidence that protection, instead of helping the countries where it prevailed, had hurt them. The silk-weavers of Macclesfield asked for protection against those of Lyons and Paterson, when it was shown that the Lyons weavers with protection were suffering far more terribly than their English competitors without it; and even the Macclesfield weavers, when it came to talking of protection on the provisions they consumed, did not think the rule would work well in that direction.

A PAPER OF CANDY.

By WILLIAM SLOANE KENNEDY.

FULLY to set forth the changes undergone by a cupful of cane-juice during its conversion, first into a cube of white sugar and then into a musk-lozenge or a lemon-drop, would require volumes. And even then one could not give a complete account of candy-making, for the reason that each skilled confectioner of hand-made candies has—like a painter or sculptor—his own incommunicable touch and methods. Yet a few words will suffice to give a general outline of the toothsome art.

We get our word "candy," not from the Cingalese city of that name, but from the Arabian *quand*, meaning sugar. Now, sugar is the crystallized juice of one of the gigantic grasses; candy, therefore, is only boiled grass-juice. As the bee collects from its two and a half million plants the nectar for its pound of honey, so man—a kind of giant bee—extracts from various plants their delicious liquors, which he afterward turns by his art into that sweet and shining sand called sugar. It was the ancients who called the crystals of sugar sweet sand and gravel—the Sanskrit word *çarkara* (our sugar) meaning gravel. Sugar is made in small quantities, it is true, from the palm-tree, the sorghum-cane, beets, California watermelons, potato-starch, and milk; yet the only kind that is used for the best candies is the clear juice of the Chinese cane, that tall and beautiful purple-striped and straw-colored plant of Malabar, Assam, Otaheite, Louisiana, and the West Indies, which even more than our *mondamin*, or tasseled maize, deserves the honor of poetical legends and myths.

The sugar-cane, like the domestic fowl, has taken two thousand years to make the circuit of the globe, always faithfully following man along a certain latitude in his westward migrations. From China or Bengal to Persia, Arabia, Spain, Madeira, Cuba, Louisiana, California—such has been its route, until now, facing westward, it may nod a welcome across the great Pacific to the shores of its old home in China and the East Indies.

In the making of candy some "raw" or brown sugar is taken (the best coming from the West Indies), but for the bulk of confections only refined sugar is used. Sugar may be clarified in small quantities by the white of eggs; in the plantation sugar-houses it is refined by lime or lime-water; but, in the great refineries, bone-black or animal charcoal is now used for this purpose, bullock's blood being discarded. When blood was used, its coagulation collected the impurities, which were then skimmed off, together with the coagulated blood. The reason of the immense height to which these refineries are built is that the liquid sugar, having once been raised to the highest story, may, in its succeeding treatment, which consists chiefly of a series of filtrations (through cloth bags and bone-black), pass down from story to story by its own gravity. After the liquor has been passed through charcoal it is boiled to evaporate the water, then crystallized, the molasses or "sugar-drip" drained off, and the residuum of sugar dried in a centrifugal machine.

The philosophy of the action of heat on boiling sugar and water is by all odds the most curious and important matter connected with the making of confections. Put a little water and crushed sugar into a clean brass kettle, and note the changes which ensue when it is placed over a brisk fire. First, when the sugar is dissolved, we have what is called "simple sirup"; continue the boiling a little longer, and the liquor, if cooled, will deposit its excess of sugar on the sides and bottom of the vessel in the form of rock-candy; boil a little longer, and the sugar shows an inclination for the granular condition; longer still, and it forms a thick, pasty, transparent mass; longer yet, and it "caramels," or turns yellow and then brown. This whole series of processes, or states, is technically divided by the confectioner into nine degrees, which form his nine mysteries, his nine points of the law. These degrees are styled the "small thread" and "large thread," the "little pearl" and "large pearl," the "blow," the "feather," the "ball," the "crack," and the "caramel," all of which are produced by a heat ranging from 230° to 260° Fahr. In the thread degree the sugar threads or strings when held up in the air by the fingers; the blow is so called from the workman dipping his skimmer into the liquor, draining it, and then blowing through the holes; if small, sparkling bubbles are seen on the farther side of the skimmer, the sirup is known to be in the "blow" degree; when in the "feather," the sirup hangs from the skimmer like flying floss, and is then said by the French to be "*à la grande plume*"—it is the point of crystallization; in the "ball" degree it makes hard balls when rolled between the fingers; in the "crack" it snaps like a clay pipe-stem—it now tends to grain; the ninth or caramel degree was discovered, or first intelligently noted, by Count Albufage Caramel, of Nismes. The greater part of our candies are made from sirup which has passed the eighth or crack degree (250° Fahr.), and the skill of the artist is shown in bringing his sirup as near as he possibly can to the caramel (260° Fahr.) without permitting it actually to reach that undesirable point; for, when sirup begins to caramel, it becomes quickly dark-colored, froths up and fills the kettle, emits puffs of smoke, and acquires a bitter taste: the sugar is then called "burnt sugar," although it is not really burned.

But it is high time we saw the magician at work. His manufacturing-room may look a little like an alchemist's den, if you choose. Here are large coppered kettles, full of steaming sirup; there, men are at work picking up Malaga grapes with a fine pair of nippers and dipping them into creamed sugar; at yonder table one is cutting up a pile of candied figs, and a pile of preserved cherries lies beside him; while still another is sugar-coating almonds in an oscillating kettle. In the middle of the room are low tables covered with marble slabs, on one of which an operator will perhaps be working out stick candy, and on another you may see long, shallow canals, or rivers, of congealing peanut or molasses candy, confined on the slab by long, solid iron bars. Scattered around are the workmen's simple tools—spatulas, strainers, molds, paste, syringes, and the like. The materials of the candy-maker are equally simple and few, consisting in the main of only three kinds of articles—sugar, flavorings, and colors. The flavors usually employed are the essential oils of various aromatic plants. Mixed with spirits these oils form extracts and essences, the extract being a stronger flavoring than the essence. The extracts of lemon, wintergreen, peppermint, clove, cinnamon, vanilla, and ginger, are used in great quantities. Extract of lemon is best prepared fresh by grating the rinds of lemons either with a grater or with cubical lumps of hard sugar, the operator being careful not to get down to the bitter white portion which underlies the outer yellow skin. As to the vanilla vine, the best Mexican pods will, if macerated in alcohol, give a fresher flavor than that of the bottled extract. The colors employed by reputable confectioners are nearly all purely vegetable, and are quite harmless. They are such as cochineal, carmine, saffron, Prussian blue* (a preparation of iron), and the like. For brown, caramel is used, and mixed with carmine it forms orange-yellow. To convince one's self of the harmlessness of these colors, one only needs to know that a bit of red coloring-matter the size of a gum-drop will color five thousand pounds of candy. Cheap candies colored with poisonous mineral stuffs are annually seized by the New York city health officers. Many French candies used to be colored not only with such disagreeable earths as umber and sienna, but with red lead, chrome-yellow, and vermilion, all of which are highly poisonous. French confectioners have now, however, not only formed themselves into a national association to protect themselves against unprincipled manufacturers, but they themselves are strictly supervised, being allowed by their government to use only the following harmless colorings: *Blues*—indigo, Prussian blue, ultramarine; *reds*—cochineal, carmine, carmine lake; *yellows*—saffron, French berries, and turmeric or fustic; *greens*—mixture of above yellows and blues; *purples*—mixture of red and blue. Cheap candies are not only often poisonous, but badly adulterated with terra alba, corn-starch, and starch-sugar or glucose. Cheap gum-drops are made from corn-starch, to which ordinary glue is sometimes added; whereas the best gum-drops are made from gum arabic and cane-sugar. Stick-candy made from glucose may be detected by its lack of sweet-

* [Prussian blue is not a vegetable color, and can not be correctly regarded as "quite harmless." In Battershall's "Food Adulteration and its Detection" it is classed, as a coloring for confectionery, among pigments of a "very objectionable character."—EDITOR.]

ness, its yellowish color, and its extreme frangibility. The nuts and fruits used in the cheaper varieties are also of poor quality, being mostly worm-eaten, old, or damaged.

To return now to our boiled sugar, which we left in the half-cooled pasty or doughy condition produced by 250° of heat. A mass of sugar in this state is the common or basic material of all candies; it is the nodal point of the line, the focus of all the processes. Antecedent to this lump of waxy paste lies a field of waving, tasseled cane, and forth from said lump proceed the thousand fantastic and toothsome dainties that glow in the golden trays of the confectioner's window.

The candy is worked by placing it on a marble slab kept warm perhaps by steam (sometimes an iron plate at one end is kept heated), and having movable iron bars for sides and ends—like the chase with which a printer's "form" is surrounded. When cool enough to handle, the flavor and the coloring ingredients are worked in. Clear candies are run into pans or trays without being kneaded or pulled; but if a white opaque article is desired, the mass is *pulled* on a hook similar to those seen in butchers' stalls—pulled out, folded, and thrown back over the hook, and again pulled until it assumes a sufficiently white appearance. For stick-candy "A" sugar is used, boiled down with a little cream of tartar to prevent crystallization. The striping of sticks is a very curious thing to see. The operator takes from the warm mass of candy a portion which he colors as desired, then draws it out into long, coarse strips, pressing them into the main mass, which is then rolled into a cylindrical shape, and gradually tapered out smaller and smaller until it is of the diameter of a stick of candy; the mass then resembles somewhat a balloon laid on its side, with its drag-rope extended on the ground beside it. Now, the colored stripes (having been rolled up in the paste) have been drawn out with the rest and in proper proportion, so that they appear both in the inside and on the outside of the stick as stripes. Sometimes a slight twist is given to the long stick before it is cut by the scissors to the required lengths. The working of candy by kneading or pulling it on the hook separates the particles and increases the bulk, so that the youngster who buys a stick of white candy imagines wrongly that he is getting more for his penny than if he had invested in a clear stick.

Lemon and other drops are now made by machines, which consist of two revolving cylinders, with holes on each side so arranged as to come exactly opposite each other when the cylinders revolve; the movement of the cylinders forces the candy into these molds.

The flat, striated cream-sticks of the shops are made simply by working the candy very thoroughly until it acquires the creamy texture. Peppermint-drops are made of granulated sugar and water heated to the boiling-point (but not actually boiled), and afterward flavored with the essence. White molasses candy is made of "coffee C" sugar, mixed with equal proportions of sugar-house and New Orleans molasses, and a little carbonate of soda; if this candy is poured into trays without working, it forms a fine, plain taffy. Nearly all cough-candies are made of boiled brown sugar, flavored or medicated with anise, camphor, cayenne pepper, and peppermint, in varying proportions. The medicated lozenges, known under the name of troches, pastilles, and pulmonic wafers, contain substances possessing demulcent, sedative, tonic, and often slightly astringent properties. Most bronchial troches are composed of extract of liquorice, sugar, gum arabic, powdered cubebs, and extract of conium.

The delicious cream bonbons, of which the most popular variety is the chocolate cream, form a group by themselves. The materials used are the best loaf or crushed sugar, water, with a little acetic acid or cream of tartar, the whole boiled to the thread degree. The creaming of the mixture, so that it melts in the mouth, is produced by rubbing it back and forth on the marble slab or against the sides of the kettle with a wooden spatula or spoon. Sugar in this state is called *fondant* by confectioners. Owing to the peculiar granular texture of the creamed sugar, it can not be cast in ordinary molds without breaking; hence the use of finely-powdered starch for molds. Plaster models of the shape desired are fastened at regular distances from each other on a flat slab, and when pressed into a tray of the starch-flour produce cavities into which the creamed sugar is then run. The starch easily separates from the bonbons when they are cool, just as the earth mold falls away from the finished iron casting. The candies are also generally shaken in a sieve to remove the starch-particles that may still adhere. If it is wished to crystallize them, they are submerged for ten or twelve hours in properly boiled sugar, with a small portion of alcohol added; when removed they will be covered with sparkling crystals. The chocolate on the outside of chocolate creams is applied by simply rolling the cream-balls in thick fluid chocolate. The chocolate is prepared by grinding it on a hot plate or bed, the heat of which melts the oil in the substance and keeps it in a fluid condition.

Children are often mystified by brandy and wine gum-drops and other *liqueur* drops. The mystery is easily penetrated. The boiled sugar is simply mixed with the brandy or flavored water, and the whole poured into starch molds. As the sirup cools on the top and the sides, the sugar crystallizes around the liquor, leaving it safely prisoned within. So, in the case of pure gum-drops not containing liquor, the evaporation of water from the surface of the gum arabic forms a hard crust, which prevents the further evaporation of the interior liquid, for a long time at least. The delicate little aromatic disks known as white lozenges are also made of gum arabic, which is mixed with dry, powdery icing-sugar, the mass then flavored, rolled flat with a wooden roller, and cut into shape with a tin cutter. In this case the sugar is not even heated or mixed with water at all. Sugar-coated confections, such as sugared almonds, pistachios, and perfumed cherry-kernels, are now generally made on a large scale by machinery, as follows: The almonds, we will say, are placed in spherical copper pans over a hot fire, and a heavy sirup allowed slowly to drip over them. The pans are heated by steam passing through coils of pipe, and are kept in continual oscillation; the water of the sirup quickly flies off in vapor, leaving the almonds covered with crystals of sugar.

The fruit-pastes sold at candy-shops are prepared by reducing the fruit—be it peach, orange, or quince—to a kind of marmalade, mixed with the exact amount of sugar required. The roots of the marsh-mallow are not often used nowadays in the compounding of the popular paste of that name. This is owing to the unpleasant taste of the roots. The juice or jelly of the apple is employed instead. The other ingredients are gum arabic, the beaten whites of eggs, and flavoring—the whole thickly dusted with powdered starch.

Chocolate caramels are made of gelatin, dairy cream, sugar, and chocolate. The delicate molasses chips made for fastidious consumers of confections are compounded of sugar and a little molasses for flavor; their brittleness is simply due to the fact that the sirup is boiled to the brittle or "crack" degree.

THE EARLIEST PLANTS.*

By Sir WILLIAM DAWSON.

THE knowledge of fossil plants and of the history of the vegetable kingdom has, until recently, been so fragmentary that it seemed hopeless to attempt a detailed treatment of the subject. Our stores of knowledge have, however, been rapidly accumulating in recent years, and we have now arrived at a stage when every new discovery serves to render useful and intelligible a vast number of facts previously fragmentary and of uncertain import.

Oldest of all the formations known to geologists, and representing perhaps the earliest rocks produced after our earth had ceased to be a molten mass, are the hard, crystalline, and much-contorted rocks named by the late Sir W. E. Logan Laurentian, and which are largely developed in the northern parts of North America and Europe, and in many other regions. So numerous and extensive, indeed, are the exposures of these rocks, that we have good reason to believe that they underlie all the other formations of our continents, and are even world-wide in their distribution. In the lower part of this great system of rocks, which, in some places at least, is thirty thousand feet in thickness, we find no traces of the existence of any living thing on the

* From the "Geological History of Plants," published by D. Appleton & Co., "International Scientific Series," vol. lxi.

earth. But, in the middle portion of the Laurentian, rocks are found which indicate that there were already land and water, and that the waters and possibly the land were already tenanted by living beings. The great beds of limestone which exist in this part of the system furnish one indication of this. In the later geological formations the limestones are mostly organic—that is, they consist of accumulated remains of shells, corals, and other hard parts of marine animals, which are composed of calcium carbonate, which the animals obtain directly from their food, and indirectly from the calcareous matter dissolved in the sea-water. In like manner great beds of iron-ore exist in the Laurentian; but in later formations the determining cause of the accumulation of such beds is the partial deoxidation and solution of the peroxide of iron by the agency of organic matter. Besides this, certain forms known as *Eozoon Canadense* have been recognized in the Laurentian limestones, which indicate the presence at least of one of the lower types of marine animals. Where animal life is, we may fairly infer the existence of vegetable life as well, since the plant is the only producer of food for the animal. But we are not left merely to this inference. Great quantities of carbon or charcoal in the form of the substance known as graphite or plumbago exist in the Laurentian. Now, in more recent formations we have deposits of coal and bituminous matter, and we know that these have arisen from the accumulation and slow putrefaction of masses of vegetable matter. Further, in places where igneous action has affected the beds, we find that ordinary coal has been changed into anthracite and graphite, that bituminous shales have been converted into graphitic shales, and that cracks filled with soft bituminous matter have ultimately become changed into veins of graphite. When, therefore, we find in the Laurentian thick beds of graphite and beds of limestone charged with detached grains and crystals of this substance, and graphitic gneisses and schists and veins of graphite traversing the beds, we recognize the same phenomena that are apparent in later formations containing vegetable *débris*.

The carbon thus occurring in the Laurentian is not to be regarded as exceptional or rare, but is widely distributed and of large amount. In Canada more especially the deposits are very considerable.

The graphite of the Laurentian of Canada occurs both in beds and in veins, and in such a manner as to show that its origin and deposition are contemporaneous with those of the containing rock.

The quantity of graphite in the Lower Laurentian series is enormous. Some years ago, in the township of Buckingham, on the Ottawa River, I examined a band of limestone believed to be a continuation of that described by Sir W. E. Logan as the Green Lake limestone. It was estimated to amount, with some thin interstratified bands of gneiss, to a thickness of six hundred feet or more, and was found to be filled with disseminated crystals of graphite and veins of the mineral to such an extent as to constitute in some places one fourth of the whole; and, making every allowance for the poorer portions, this band can not contain in all a less vertical thickness of pure graphite than from twenty to thirty feet. In the adjoining township of Lochaber Sir W. E. Logan notices a band from twenty-five to thirty feet thick, reticulated with graphite veins to such an extent as to be mined with profit for the mineral. At another place in the same district a bed of graphite from ten to twelve feet thick, and yielding twenty per cent. of the pure material, is worked. As it appears in the excavation made by the quarrymen, it resembled a bed of coal; and a block from this bed, about four feet thick, was a prominent object in the Canadian department of the Colonial Exhibition of 1886. When it is considered that graphite occurs in similar abundance at several other horizons, in beds of limestone which have been ascertained by Sir W. E. Logan to have an aggregate thickness of thirty-five hundred feet, it is scarcely an exaggeration to maintain that the quantity of carbon in the Laurentian is equal to that in similar areas of the Carboniferous system.

If we ask more particularly what kinds of plants might be expected to be introduced in such circumstances, we may obtain some information from the vegetation of the succeeding Palæozoic age, when such conditions still continued to a modified extent. In this period the club-mosses, ferns, and mare's-tails engrossed the world and grew to sizes and attained degrees of complexity of structure not known in modern times. In the previous Laurentian age something similar may have happened to algæ, to fungi, to lichens, to liverworts, and mosses. The algæ may have attained to gigantic dimensions, and may have even ascended out of the water in some of their forms.

Whether this early Laurentian vegetation was the means of sustaining any animal life other than marine protozoa, we do not know.

If we ask to what extent the carbon extracted from the atmosphere and stored up in the earth has been, or is likely to be, useful to man, the answer must be that it is not in a state to enable it to be used as mineral fuel. It has, however, important uses in the arts, though at present the supply seems rather in excess of the demand, and it may well be that there are uses of graphite still undiscovered, and to which it will yet be applied.

Finally, it is deserving of notice that, if Laurentian graphite indicates vegetable life, it indicates this in vast profusion. That incalculable quantities of vegetable matter have been oxidized and have disappeared we may believe on the evidence of the vast beds of iron-ore; and, in regard to that preserved as graphite, it is certain that every inch of that mineral must indicate many feet of crude vegetable matter.

It is remarkable that, in ascending from the Laurentian, we do not at first appear to advance in evidences of plant-life. The Huronian age, which succeeded the Laurentian, seems to have been a disturbed and unquiet time, and, except in certain bands of iron-ore and some dark slates colored with carbonaceous matter, we find in it no evidence of vegetation. In the Cambrian a great subsidence of our continents began, which went on, though with local intermissions and reversals, all through the Siluro-Cambrian or Ordovician time. These times were, for this reason, remarkable for the great abundance and increase of marine animals rather than of land-plants. Still, there are some traces of land vegetation.

The oldest plants known to me, and likely to have been of higher grade than algæ, are specimens kindly presented to me by Dr. Alleyne Nicholson, of Aberdeen, and which he had named *Buthotrephis Harknessii* * and *B. radiata*. They are from the Skiddaw rocks of Cumberland. On examining these specimens, and others subsequently collected in the same locality by Dr. G. M. Dawson, while convinced by their form and carbonaceous character that they are really plants, I am inclined to refer them not to algæ, but probably to rhizocarps. They consist of slender branching stems, with whorls of elongate and pointed leaves, resembling the genus *Annularia* of the coal formation. I am inclined to believe that both of Nicholson's species are parts of one plant, and for this I have proposed the generic name *Protannularia* (Fig. 1). Somewhat higher in the Siluro-Cambrian, in the Cincinnati group of America, Lesquereux has found some minute radiated leaves, referred by him to the genus *Sphenophyllum*, which is also allied to rhizocarps. Still more remarkable is the discovery in the same beds of a stem with rhombic areoles or leaf-bases, to which the name *Protostigma* has been given.† If a plant, this may have been allied to the club-mosses. This seems to be all that we at present know of land-vegetation in the Siluro-Cambrian. So far as the remains go, they indicate the presence of the families of rhizocarps and of lycopods.

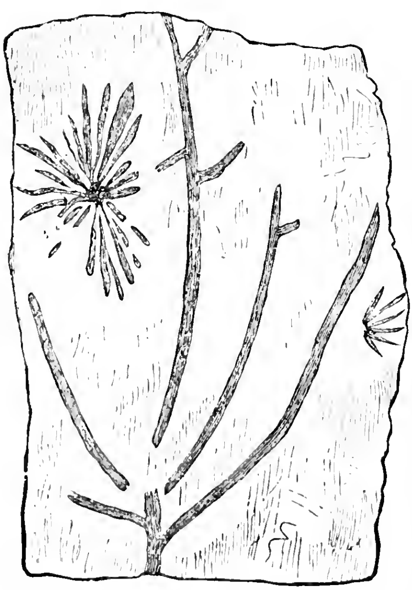

Fig. 1.—*Protannularia Harknessii* (Nicholson), a probable Rhizocarp of the Ordovician period.

If we ascend into the Upper Silurian, or Silurian proper, the evidences of land-vegetation somewhat increase. In 1859 I described, in The "Journal of the Geological Society," of London, a remarkable tree from the Lower Erian of Gaspé, under the name *Prototaxites*, but

* "Geological Magazine," 1869. † *Protostigma sigillarioides*, Lesquereux.

for which I now prefer the name *Nematophyton*. When in London, in 1870, I obtained permission to examine certain specimens of spore-cases or seeds from the Upper Ludlow (Silurian) formation of England, and which had been described by Sir Joseph Hooker under the name *Pachytheca*. In the same slabs with these I found fragments of

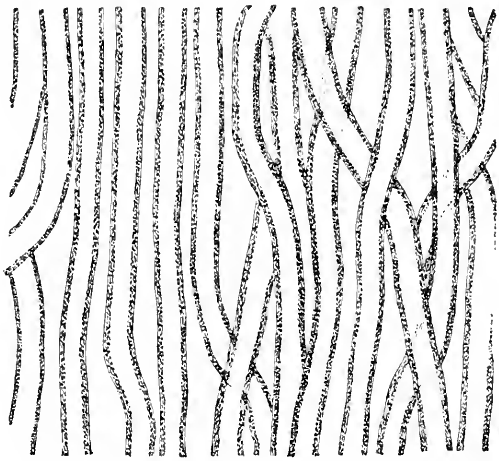

FIG. 2.—*Nematophyton Logani* (magnified). Vertical section.

fossil wood identical with those of the Gaspé plant. Still later I recognized similar fragments associated also with *Pachytheca* in the Silurian of Cape Bon Ami, New Brunswick. Lastly, Dr. Hicks has discovered similar wood, and also similar fruits, in the Denbighshire grits, at the base of the Silurian.*

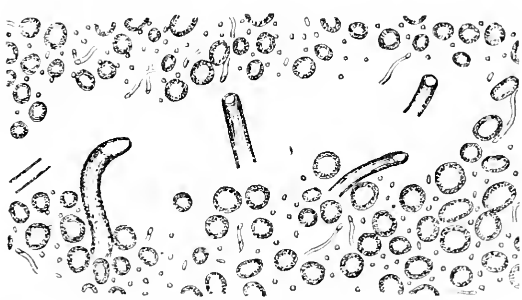

FIG. 3.—*Nematophyton Logani* (magnified). Horizontal section, showing part of one of the radial spaces, with tubes passing into it.

They are trees of large size, with a coaly bark and large spreading roots, having the surface of the stem smooth or irregularly ribbed, but with a nodose or jointed appearance. Internally, they show a tissue of long, cylindrical tubes, traversed by a complex network of horizontal tubes thinner walled and of smaller size. The tubes are ar-

* "Journal of the Geological Society," August, 1881.

ranged in concentric zones, which, if annual rings, would in some specimens indicate an age of one hundred and fifty years. There are also radiating spaces, which I was at first disposed to regard as true medullary rays, or which at least indicate a radiating arrangement of the tissue. They now seem to be spaces extending from the center toward the circumference of the stem, and to have contained bundles of tubes gathered from the general tissue and extending outward perhaps to organs or appendages on the surface. That the plant grew on land I can not doubt, from its mode of occurrence; that it was of durable and resisting character is shown by its state of preservation; and the structure of the seeds called *Pachytheca*, with their constant association with these trees, give countenance to the belief that they are the fruit of *Nematophyton.* Of the foliage or fronds of these

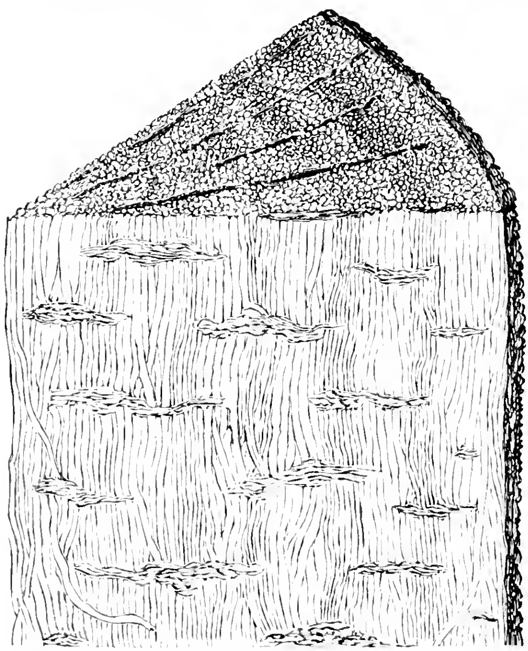

FIG. 1.—*Nematophyton Logani* (magnified). Restoration.*

strange plants we unfortunately know nothing. They seem, however, to realize the idea of arboreal plants having structures akin to those of thallophytes, but with seeds so large and complex that they can scarcely be regarded as mere spores.

Multitudes of markings occurring on the surfaces of the older rocks have been referred to the algæ or sea-weeds, and indeed this group has been a sort of refuge for the destitute to which paleontologists have been accustomed to refer any anomalous or inexplicable form which, while probably organic, could not be definitely referred

* Figs. 2, 3, and 4 are drawn from nature, by Professor Penhallow, of McGill College.

to the animal kingdom. There can be no question that some of these are truly marine plants; and that plants of this kind occur in formations older than those in which we first find land-plants, and that they have continued to inhabit the sea down to the present time. It is also true that the oldest of these algæ closely resemble in form plants of this kind still existing; and, since their simple cellular structures and soft tissues are scarcely ever preserved, their general forms are all that we can know, so that their exact resemblance to or difference from modern types can rarely be determined. For the same reasons it has proved difficult clearly to distinguish them from mere inorganic markings or the traces of animals, and the greatest divergence of opinion has occurred in recent times on these subjects.

The author of this work has given much attention to these remains, and has not been disposed to claim for the vegetable kingdom so many of them as some of his contemporaries.* I believe there are many real examples of fossil algæ, but the difficulty is to distinguish them.


Fig. 5.—*Buthotrephis Grantii*, a genuine Alga from the Silurian, Canada.

The genus *Buthotrephis* of Hall, which is characterized as having stems, subcylindric or compressed, with numerous branches, which are divaricating and sometimes leaf-like, contains some true algæ. A beautiful species, collected by Colonel Grant, of Hamilton, and now in the McGill College collection, may be described as follows:

Buthotrephis Grantii, S. N. (Fig. 5).—Stems and fronds smooth and slightly striate longitudinally, with curved and interrupted striæ. Stem thick, bifurcating, the divisions terminating in irregularly pinnate fronds, apparently truncate at the extremities. The quantity of carbonaceous matter present would indicate thick, though perhaps flattened, stems and dense fleshy fronds.

It may be well to mention the remarkable Canda-Galli fucoids, referred by Hall to the genus *Spirophyton*, and which are characteris-

* "Impressions and Footprints of Aquatic Animals," "American Journal of Science," 1873.

tie of the oldest Erian beds. The specimens which I have seen from New York, from Gaspé, and from Brazil, leave no doubt in my mind that these were really marine plants, and that the form of a spiral frond, assigned to them by Hall, is perfectly correct. They must have been very abundant and very graceful plants of the early Erian, immediately after the close of the Silurian period.

It is not surprising that great difficulties have occurred in the determination of fossil algæ. Enough, however, remains certain to prove that the old Cambrian and Silurian seas were tenanted with seaweeds not very dissimilar from those of the present time. It is further probable that some of the graphitic, carbonaceous, and bituminous

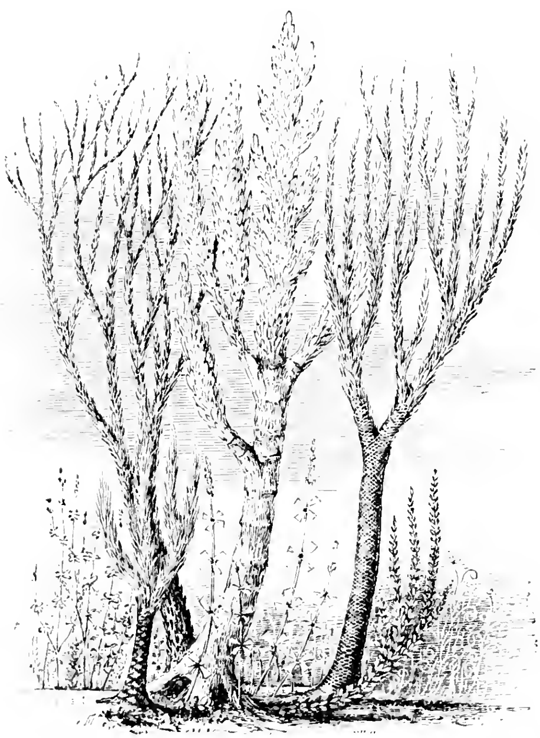

Fig. 6.—Silurian Vegetation Restored. *Protannularia, Berwynia, Nematophyton, Sphenophyllum, Arthrostigma, Psilophyton.*

shales and limestones of the Silurian owe their carbonaceous matters to the decomposition of algæ, though possibly some of it may have been derived from graptolites and other corneous zoöphytes. In any case, such microscopic examinations of these shales as I have made, have not produced any evidence of the existence of plants of higher grade, while those of the Erian and Carboniferous periods, similar to the naked eye, abound in such evidence. It is also to be observed that, on the surfaces of beds of sandstone in the Upper Cambrian, carbonaceous *débris*, which seems to be the remains of either aquatic or land plants, is locally not infrequent.

Referring to the land vegetation of the older rocks, it is difficult to picture its nature and appearance. We may imagine the shallow waters filled with aquatic or amphibious rhizocarpean plants, vast meadows or brakes of the delicate *Psilophyton* and the starry *Protannularia* and some tall trees, perhaps looking like gigantic club-mosses, or possibly with broad, flabby leaves, mostly cellular in texture, and resembling algæ transferred to the air. Imagination can, however, scarcely realize this strange and grotesque vegetation, which, though possibly copious and luxuriant, must have been simple and monotonous in aspect, and, though it must have produced spores and seeds and even fruits, these were probably all of the types seen in the modern acrogens and gymnosperms.

> "In garments green, indistinct in the twilight,
> They stand like Druids of old, with voices sad and prophetic."

Prophetic they truly were of the more varied forests of succeeding times, and they may also help us to realize the aspect of that still older vegetation, which is fossilized in the Laurentian graphite; though it is not impossible that this last may have been of higher and more varied types, and that the Cambrian and Silurian may have been times of depression in the vegetable world, as they certainly were in the submergence of much of the land.

These primeval woods served at least to clothe the nakedness of the new-born land, and they may have sheltered and nourished forms of land-life still unknown to us, as we find as yet only a few insects and scorpions in the Silurian. They possibly also served to abstract from the atmosphere some portion of its superabundant carbonic acid harmful to animal life, and they stored up supplies of graphite, of petroleum, and of illuminating gas, useful to man at the present day. We may write of them and draw their forms with the carbon which they themselves supplied.

The considerations adduced by Professor Alfred Marshall, in answer to the question whether London is healthy, are applicable to other large cities. Many people live long in the metropolis, not because it is healthy, but because their exceptional health and strength induced them to come there. Most of the inhabitants who were born elsewhere were, when they came, the picked lives, the strongest members of their several parishes. Numbers of London-born people have gone away to live elsewhere because they felt themselves unequal to the strain of metropolitan life. The death-rate of young women is low, partly because of the favorable conditions of life of domestic servants, and partly because young people who come to the city are likely to go home as soon as they get ill, to swell, perhaps, the death-rate of their native towns. Really, London is very unhealthy; for, although the population consists mainly of picked lives, and despite all the resources of wealth to counteract disease, the expectation of life is below the average.

CHINESE SUPERSTITIONS.

By ADÈLE M. FIELDE.

THE superstitious beliefs and observances of the Chinese are numberless, and they occupy more or less the time and mind of every individual in the nation. Those here recorded are common among the people near Swatow. I am unable to say how many of them are purely local.

When a child is just one month old, the mother, carrying it in a scarf on her back, induces it to look down into a well. This is supposed to have a mentally invigorating effect, producing courage, and deepening the understanding.

A mother feeds her young infant from a cup rather than from a bowl or plate, because a bowl, being capacious, has an occult influence in making the child a large eater; while a plate, being shallow, causes him to throw up his food on slight provocation. The cup, being small and deep, insures his taking but little food, and keeping it for assimilation.

When a child becomes ill, the mother gathers thorns from twelve species of plants and makes an infusion in which she washes the child, hoping to wash the disease, with the demon that produces it, into the water. She then carries the water to an open space where many people go to and fro, and there throws it upon the ground. As she goes from her own house, the inhabitants of the streets she traverses shut their doors, to prevent the disease from entering their abodes. A woman of my acquaintance recently told me that, having no fear of demons, she did not shut her door when a neighbor passed her house carrying water in which a child having fever and ague had just been washed, and the very next day she herself had chills!

If a child falls from a high place to the ground, spirit-money is immediately burned upon the spot by the mother, to propitiate the demon who is trying to pull the child down to destruction.

When a child has fallen, there is danger that he may have left his twelve wits in the earth on which he fell, so the mother at once makes with her empty hand the motion of dipping from the ground to the child's chest. Thus she replaces in the child what might otherwise be permanently lost in the soil. If a man falls into a cesspool or well, a long-handled dipper is used to dip out and restore to his bosom his scattered senses; then three sheets of spirit-money are thrown burning into the well, and a heavy stone is cast after it.

It is unlucky to leave much hair on a boy's head when he is old enough to wear a queue; therefore the head should be shaved so as to leave but a small patch on the crown. Abundant hair is symbolic of a burden on the head, and a heavy queue may soon bring the care of the family upon the boy through the death of his father.

During the month succeeding the birth of a child the mother must not cross the threshold of another person's room. Should she do this, she will endanger the welfare of the occupants, and in her next life she will perpetually scrub the floor of the room entered.

A girl who is partaking of the last meal she is to eat in her father's house previous to her marriage, sits at the table with her parents and brothers; but she must eat no more than half the bowl of rice set before her, else her departure will be followed by continual scarcity in the domicile she is leaving.

If a bride breaks the heel of her shoe in going from her father's to her husband's house, it is ominous of unhappiness in her new relations.

A piece of bacon and a parcel of sugar are hung on the back of a bride's sedan-chair as a sop to the demons who might molest her while on her journey. The "Three Baneful Ones" are fond of salt and spices, and the "White Tiger" likes sweets.

A bride may be brought home while a coffin is in her husband's house, but not within one hundred days after a coffin is carried out. Domestic troubles are sure to come upon one who is married within a hundred days after a funeral.

A bride, while putting on her wedding garments, stands in a round, shallow basket. This conduces to her leading a placid, well-rounded life in her future home. After her departure from her father's door, her mother puts the basket over the mouth of the oven, to stop the mouths of all who would make adverse comment on her daughter, and then sits down before the kitchen range, that her peace and leisure may be duplicated in her daughter's life.

A bride must not, for four months after her marriage, enter any house in which there has recently been a death or a birth, for if she does so there will surely be a quarrel between her and the groom. If a young mother goes to see a bride, the visitor is looked upon as the cause of any calamity that may follow.

One who has ordered a coffin must guide its bearers by the shortest road to the house in which the corpse lies. The bearers of an empty coffin may not inquire their way at any house nor of any person. To mistake the road when carrying a coffin, or to take it to any house other than that where it is wanted, brings terrible misfortunes on persons thereby disturbed. Any insult may with impunity be offered to coffin-sellers who mistake the destination of their goods.

One should not catch butterflies, since departed spirits frequently incorporate themselves in these insects, and flit back to see what is being done in their old dwelling. A man is known to have died the day after killing a butterfly.

When a cow's tooth is found in a field, it is put on a shelf with the gods, and keeps demons from entering the house.

If, when one is under the open sky, a bird drops excrement upon one, the omen is bad, and must be immediately offset by going to persons of three different surnames, all unlike one's own, and begging a little rice to eat.

If one, who is walking along a road, has a sudden attack of colic, he procures three paper bags that have held incense, and burns them on the spot where he was when he began to feel the pain, to pacify the demon of the locality. A demon's day is man's night, and man's night is a demon's day; therefore candles are lighted when offerings are made to demons by daylight.

If a fly falls into the porridge, if a magpie chatters on the roof, or if two chickens fight, it is a sign that a guest is coming.

A cock that crows before midnight foretells a death in the family. Spirit-money must be burned, a hoop must be put in the front door at its top, and the crowing fowl must be given away or sold. No one would knowingly buy a fowl that crowed before midnight, and, if it were sold, no one would dare use the cash received for it.

When a person commits suicide by hanging, the beam from which the body hung is cut out from the roof and burned, or thrown into the river to be carried away by the current. The floor underneath the feet of the hanging corpse is also dug up and replaced by new material. Thus the evil influence which would inhere in the spot is eradicated from the house.

If a pot of money is found, a rice-flour cake is put in the place of each coin taken, and spirit-money is burned as an offering to any spirit that might be irritated by the removal of the treasure.

No one picks up a girdle found in the road, through fear that some one may have been hung by it, and that the spirit may follow and worry the possessor. If a single coin or other article is found, it is picked up with fear; but if a pair or an even number of things be found, they are taken without anxiety, for odd numbers are unlucky, while even numbers are lucky. Three is a particularly unlucky number. Three persons, therefore, never sit together at a table, and no couple marries when there are six years of difference in age, because six is twice three.

It is not considered respectable for an old man to be without a beard, nor for a young man to wear one. A youth who puts on an air of wisdom is called a beardless old man. When a man decides to let his beard grow, his sons and sons-in-law make a feast for him, and congratulate him on his longevity. No one who has once grown a beard cuts it off, as such an act would inevitably bring disasters upon his family.

If one sneezes on New-Year's-eve while preparing for bed, he fears misfortune during the next year, unless he goes to three families of different surnames, and begs from each a little cake, shaped like a tortoise, and in common use at the end of the year as an emblem of long life. These cakes must be eaten by the sneezer before midnight.

Sneezing is generally a sign that somebody is thinking of one. A man walking along the road knew that a stranger was walking behind him. The first man sneezed, and, though he was a bachelor, he liked to appear to be the head of a household, and exclaimed, "Ah, my wife is thinking of me!" The second man, on reaching home, asked his wife why she had not thought of him at all that day. The wife inquired why he asked that unusual question, and, after much persuasion, got him to reveal the reason for his unjust accusation of disregard. When he told her that he had not sneezed, while his fellow-traveler had received that proof of a wife's remembrance, the wise little woman told her jealous spouse that on the morrow he would have evidence of her consideration. The next morning he went to carry two jars of oil to a neighboring village, and, as the sun was hot, his wife urged his wearing a wet towel on his head under his hat to protect him from the heat. The towel was cold, and gave the poor man a chill. Just as he was going down a steep slope he sneezed violently, stumbled, fell, and spilled the oil. When he reached home that evening, he said to his wife, "If you are going to think of me when I am absent, I wish you would do it when I am on level ground, and not when I am going down-hill!"

THE PRESENT STATUS OF MINERALOGY.

By Professor F. W. CLARKE.

IN the study of any branch of science it is well to pause occasionally, that we may look about us, see where we are, what we are doing, and what we had better do. For that which distinguishes science from empirical knowledge is its unity of purpose, its coherence, and its definite relation of part to part; and these features develop best when attention is temporarily withdrawn from the details of special research. As a science grows, and increases in complexity, the individual worker must confine himself more and more to particular investigations; these, to him, assume undue importance, and their higher significance as part of a broad general field is ignored or lost. The petty details are essential; but, incoördinated, they make not science, but chaos. The scattered bricks are good material, but they must be brought together into one symmetrical structure.

These remarks are particularly true of a concrete science like mineralogy. Here we have a branch of knowledge which rests upon the observation of material facts; and which, hitherto, has owed little to abstract reasoning. It has grown up, partly as a "natural" science, partly as an outlying division of chemistry; and hypothesis has had little to do with its upbuilding. The mineralogist collects, observes, describes, and classifies species as he finds them, determines their mode of occurrence, chemical composition, and physical properties; and then, too often, considers his work finished, except as regards the gathering of more data of like kind, with possible refinements of method. The relations and bearing of mineralogy toward other sciences have been, with rare exceptions, slighted; and a general theory of its nature and purpose has hardly been considered at all.

Of late years, however, an improvement has been noticeable. New lines of investigation are open, new modes of thought are recognized, and philosophical treatment is in order. In mineralogy, as in most other sciences, a central stem of growth is perceivable, around which the facts are grouping themselves to obvious advantage. Lithology (which mainly deals with the association of minerals), the study of pseudomorphs and alterations, and the synthesis of many mineral species, all furnish lines of evidence which converge toward certain general conceptions dominating the entire subject, and linking it intimately with other divisions of scientific thought. The discovery of new species is no longer the main object of the mineralogist, who is learning to look upon the correlation of known minerals as much more important.

In the study of minerals as such, apart from their geological relations, two main avenues of research are followed: First, the physical method, which is now mainly devoted to morphological considerations; and, secondly, the chemical method, which discusses composition. Philosophically regarded, the former method is subordinate to the latter, for physical properties, including form, are undoubtedly functions of chemical structure, which alone is fundamental and determining. A mineral species is best denoted as a definite chemical substance occurring in the crust of the earth; and its integrity depends upon the sharpness with which its constitution can be made out. In any given case, the claims of a species to recognition depend upon definiteness of composition, together with, in less degree, definiteness of form. The latter consideration, however, is only approximately general; for in some cases it can not be determined, and some minerals are amorphous; whereas the former test applies without exception. Crystalline form is but one property of a substance—more important to the mineralogist, doubtless, than any other physical condition, yet governed ultimately by chemical determinations. *The nature of the substance* is the one fundamental fact in the description of any mineral species.

It is not always easy, however, to prove definiteness of composition. A mineral may, to all outward appearance, be uniform in texture, and yet, seen in thin section under the microscope, it may be found to contain several different things. The microscope, therefore, with its adjunct the polariscope, is an important weapon in the hands of the mineralogist. By its aid he determines the mechanical purity of a given specimen; and upon examination under polarized light he can tell something as to its crystalline system, even though distinct crystals as such may not be visible. Few minerals are wholly free from mechanical admixtures, which complicate analysis, and vitiate the conclusions drawn from analytical results. Proof of homogeneity is an essential datum in the establishment of a mineral species. Many a supposed species has been overthrown by the microscope.

But a mineral may be apparently homogeneous, and yet indefinite chemically; for, apart from mere impurities which are unrecognizable by physical means, there are modes of admixture even more difficult to determine. Two distinct compounds may crystallize together in varying proportions, so as to yield definite forms which are, to all physical tests, perfectly homogeneous. Such mixtures of "isomorphous" substances are almost infinite in number; they are among the commonest occurrences in Nature; and they complicate the mineralogic problem enormously. Theoretically, a species is easily defined; practically, the definition is most troublesome. Oftentimes all the members of an isomorphous group are regarded as one species, in which certain analogous elements are said to "replace" each other. Iron and alumina are thus mutually replaceable; so are the oxides of the magnesia group; so also are sodium and potassium. But this usage, though common and sanctioned by weighty authorities, is not rigidly scientific. It is allowable conventionally, but only so long as we do not lose sight of what it really means. The so-called replacement is in reality a phenomenon of mixture between isomorphous salts of allied metals or acids, which salts are the true, definite species. For example, garnet varies in composition in just this peculiar way, and six or more compounds, all different but similar, are represented in it. Sometimes we find one of these compounds nearly pure; but oftener two or more exist in a given crystal. Garnet, therefore, is not one species, but a group, and should be so treated. A mixture is a mixture, whether visibly so or not, and has no title to specific naming. On a systematic basis the current policy needs modification; for it varies too widely and can not be universally applied. Seeking to evade one set of difficulties, it creates new ones.

In consequence of the tendency toward mixture among species, and of the wide-spread fashion of regarding the crystal as the mineralogical unit, there has grown up a general belief that minerals are in most cases very complex chemically. Some species, undoubtedly, are quite simple, like quartz, fluor-spar, or calcite; but others, especially among the silicates, appear to be most complicated, and even variable, in composition. This complexity, which is in great part due to the influences already mentioned, is perhaps apparent rather than real. Mixtures, whether crystalline or mechanical, can hardly be given either simple or definite chemical formulæ. The true individual units are probably not very complex, for their modes of origin favor simplicity. A complex molecule is likely to be unstable—the more complex, the more unstable; while minerals seem to be generated under conditions adverse to instability. Some have been deposited from solutions in which many reactions were possible; others originate under conditions of high temperature; and in either case only the more stable compounds are likely to be formed. Simplicity of chemical structure is therefore to be presumed; and the reverse should be the exception rather than the rule. Great complexity may sometimes exist; but in most cases it may be traced to the commingling of isomorphous bodies, or to impurities which have been overlooked.

Suppose, now, that for a given mineral the true chemical composition has been made out and expressed in a definite formula. All errors due to interminglings of other bodies may have been eliminated, and yet something still remains to be done before we can truly understand the nature of the substance. Here we must draw from the stock of conceptions furnished to science by organic chemistry. Two or more compounds, identical in percentage composition, may be widely different in other respects. Among organic compounds this fact is one of the commonplaces, but among minerals it is rarer and less easily explained. For example, calcite and aragonite, differing in crystalline form and in physical properties, are alike in composition, both being simply carbonate of lime. The differences lie within the molecule, and arise from the fact that the atoms are differently grouped or arranged. Partly from physical evidence, and partly from ultimate composition, the organic chemist infers the number of atoms in an organic molecule, and by a study of the changes which a substance can undergo he draws conclusions as to the position of these atoms with reference to each other. These conclusions are expressed in terms of chemical structure. By reasoning, too special for review here, he accounts for the differences between two "isomeric" compounds, and by means of "structural formulæ" he symbolizes the relations of each to the other. Can similar reasoning be applied to mineral species?

It is easy enough to devise structural formulæ, even with all the limitations which chemical science imposes. Given a certain number of atoms, built up into a molecule, and we can represent them as arranged in a variety of ways. But, to have value, that way must be chosen which shall represent the relations of the substance under consideration to other substances, and which shall, therefore, fulfill a definite scientific purpose in the interpretation of known facts. Formulæ so devised are of great utility; they shed much light upon the changes which bodies undergo, and upon their possible modes of generation; and this they do independently of all speculative considerations as to their ultimate meaning. The simpler chemical formulæ express composition only; the structural formulæ indicate function also. The latter, equally with the former, is essential to the discussion of our fundamental problem, namely, to determine *the nature of the substances* with which we deal.

At the present moment mineralogy is just entering upon this higher field of chemical study. Some mineralogists are vaguely distrustful of the new structural conceptions; some are indifferent to them;

others are openly opposed. The latter, however, mostly belong to a school of thought which, chemically speaking, is obsolescent; and by refusing to accept the later notation they bar the doors of progress against themselves. They discover details, but they develop no principles. A reasonable distrust of novelty, however, is always legitimate; and the question may fairly be raised whether the methods of reasoning which are valid in organic chemistry can safely be applied to mineralogic research. The organic chemist deals with compounds for which the starting-points are simple and well known; in many cases he can determine molecular weights with ease; and his material is so plastic that it can be altered, built up, or transferred in readily traceable ways. Every step in his processes can be followed, and his results may be checked from many sides. Minerals, on the other hand, are hard and stubborn; they form slowly and change with difficulty; they can not be handled as systematically as their organic analogues, and the evidence concerning their chemical structure is therefore less complete and convincing. Still, the case is not quite hopeless, and much positive work may be done.

Just at this point the main lines of mineralogic investigation seem to converge toward the central stem of growth. Leaving out of account mere questions of descriptive detail, the raw material of scientific thought, we may consider three great divisions of study which touch the problem of chemical structure. First of all, we have the branch of associative mineralogy. Minerals do not occur together at random, in all conceivable groupings, but only in accordance with definite laws which are now subjects for investigation. We can not clearly formulate these laws as yet, but we are learning much about them empirically; so that in many cases, upon finding one species, we instinctively look for certain others, which we are quite sure must exist with or near it. Some minerals are found in granite veins, some in volcanic rocks, and some only in ore-bodies, and each one may be evidence for its neighbors. The chief work of the lithologist is in a limited portion of this field; for he considers the minerals which are aggregated into rock-masses, which latter represent definite and frequently recurring associations exhibited upon a large scale. The very classification of the rocks is based upon their mineralogical characteristics. Lithology, however, takes into account only a small minority of known species.

Now each well-established group of mineral associates indicates something relative to their origin. It represents the collective conditions under which they came into existence, and points distinctly toward the chemical reactions which formed them. If we study any one locality closely, we shall discover some details of curious significance. Some minerals occur enveloped by, inclosed in, or implanted upon others; some line cavities, and some represent incompleted processes. We see clearly that one was formed before or after another;

we trace out the left-over material which was last deposited; we find secondary growths built up from more primitive substances. Throughout we gather evidence bearing upon the life-history of each mineral, and this may be directly correlated with the conception of chemical structure. When we can determine the conditions under which a compound can be formed, we shall have made a long step forward in understanding the nature of the substance.

The second of our three lines of investigation is closely allied to the first, and, indeed, overlaps it somewhat. It is the study of alterations. A mineral has not only an origin and growth, but also a process of decay, during which its material, disintegrated, is made over into new forms. It is very common to find a crystal with its nucleus unchanged, and its surface transformed into some other species. Some of these alterations are easy to understand; as when, by oxidation, a cube of iron pyrites becomes a cube of the brown hydroxide, limonite; or when an arseniate or sulphate is derived from an arsenide or sulphide. Other changes, however, are less simple, such as the transformation of topaz into mica, or of corundum into margarite; but all of them tell something as to the nature of the substance altered, and help to elucidate the problems of structure and function. An alteration product is the record of a chemical reaction, which may be traced and reasoned about; and the evidence which it offers is quite analogous to that used by the organic chemist to determine the structure of a carbon compound. In the latter case alteration products—that is, derivatives—are produced artificially; in the former the mineralogist finds them ready formed in Nature. Unfortunately, however, such alteration products are not attractive specimens; and the ordinary collector throws them aside as worthless. An altered crystal has lost its perfection and beauty, and is valuable only for what it signifies. But, from a scientific point of view, its value is real and considerable, if only it be studied thoroughly, apart from superficial appearances, and without jumping at conclusions. Here, again, the microscope and the chemical analysis are necessary coadjutors.

One line of research yet remains to be considered. The two already disposed of deal with material as gathered in the field; the third is an affair of the laboratory. Of late years many mineralogists have been actively at work upon the synthesis of minerals, building up their crystals by artificial means, and reproducing in a rapid way the slower processes of Nature. Many species have thus been formed in well-defined condition; and other compounds, different from but closely analogous to well-known minerals, have also been produced. Every year there are great advances in this field of work, and every step which is taken is in the direction of the main problem. Sometimes results are attained by methods unlike those which grew the native crystal; but even then new light is shed upon its nature, and we know more of its possible modes of genesis. Some experiments also bear upon the subject of alterations ; and definite alteration products are artificially obtained. So far, little has been done toward generalizing upon this class of observations ; but, as the facts accumulate, new relations will appear and reasoning must follow. Each experiment suggests new experiments ; each discovery points toward others, and the connecting theories will grow up around the conception of chemical structure. It is the only conception yet clearly recognized which is general enough to cover the whole field.

It has already been argued that the physical study of minerals is subordinate to their chemical investigation, for the reason that all properties depend upon composition. Physical researches, nevertheless, have great value in mineralogy, and a paper under the caption of this essay would be wretchedly incomplete if it failed to consider them. Physical data, moreover, aid in the discussion of chemical structure, and point out analogies of weighty significance. Specific gravity, for instance, is always an important datum in the study of a species ; and the ratio between it and the molecular weight of a compound tells us something of the condensation which the elementary material has undergone in combining. One eminent mineralogist is now using this ratio as a basis for mineral classification, especially among the silicates ; and his results are likely to emphasize the conclusions drawn from quite different sources. This method of study, however, presupposes a knowledge of true chemical composition. With the latter it means much ; alone it signifies little.

Upon the thermal and electrical properties of minerals comparatively little has been done ; and that little has slight reference to mineralogy in general. The optical constants, on the other hand, are elaborately studied by mineralogists, on account of their direct relations to crystalline form. Indeed, optical and crystallographic work is a dominant feature of modern mineralogical investigation, although a great part of it never rises above the plane of mere descriptive detail. In its higher aspect it deals with the internal molecular structure of crystals, and so furnishes data which may some day be connected with the broader general conceptions of the chemical field of research. The question of how the atoms are grouped has a mechanical as well as a chemical side ; and some time it will be systematically attacked from both directions. At present we only see the future possibility of so handling the physical evidence ; but the expectation is philosophically just. To-day a knowledge of crystalline form is mainly useful in the identification of minerals ; for by it we may determine a species without destroying the specimen ; but its deeper potential significance is none the less apparent. Along these lines we may safely prophesy progress, which can only end in the complete correlation of all mineralogic facts, and therefore in the solution of the fundamental problem.

Looked at from the descriptive side alone, mineralogy is a small affair. Only about a thousand species are known, and one large volume may fairly cover the field. It is when we consider the mineral as a growth—as a body having a past and a future—that broad treatment of the subject becomes possible. The geologist, dealing with phenomena of the grandest character, sees at a first glance little that is attractive in mineralogy. He forgets that mineral species make his alphabet, and that upon their properties the properties of rock-masses must depend. He can not safely generalize upon the one without knowing something of the other. He can not understand the chemical changes occurring in the earth's crust, if he ignores the separate units and the reactions of which they are capable. The very genesis of many rocks must depend upon the conditions under which their individual units can concurrently exist, and the latter must be known before the larger question can be adequately handled. Mineralogy gives to the geologist the weightiest of evidence. To the chemist also it is something more than debtor. It gives him, ready made, whole groups of compounds which else would be difficultly attainable, and these are the starting-points for many lines of research. The true character of each science is best seen in the interaction of all the sciences. Each in its way is both servant and master; not one can stand wholly alone.

THE UNIFORMITY OF SOCIAL PHENOMENA.

By F. X. von NEUMANN-SPALLART.

THE surprising consequences which have attended investigations in natural science have excited among the representatives of historical and speculative studies a desire to reach results of corresponding value by the application of observation and analysis to the affairs of life. In this manner has arisen a new school of historical research, which applies the facts of physical geography, anthropology, ethnography, and other related branches of science, to the explanation of events, and by this means has passed from mechanical transcription and compilation to the examination into the natural, causal connection of things. In the same way, speculative philosophy has happily become an inductive branch of investigation, and instead of the "eloquent words" with which metaphysics used to labor, scientific analysis satisfies the aspirations in that direction, and is reviving with its refreshing breath the withered branches of the world's wisdom. It is not out of course, then, that the sciences of social life also should try to discard the tinsel of empty words and to gain by scientific methods a concrete understanding and a real view of their conditions. The question has thus arisen, whether the endlessly complicated and shifting events which are incessantly modifying the aspects of human society can be followed up and explained by natural laws;

whether there is, in fact, a social physiology. Investigation in the ordinary sciences was facilitated by the discovery, which was early made, that its objects grouped themselves in classes, of which each individual corresponded with a common type, and that what was observed of one could be predicated of all of its class. Were social phenomena susceptible of a similar generalization?

The question has only recently been answered with clear knowledge; but hints of the solution were given two or three hundred years ago to one or two favored thinkers. Giambattista Vico made the first approach to it toward the close of the seventeenth century, in his "Scienza nuova." Johann Peter Süssmilch gained another glimpse of it a hundred years afterward. Half a century after him, Herder advanced the doctrine that a plan ruled in social development, the discovery of which must be sought through the study of the philosophy of history. The application of mathematical calculations to human events is due to two astronomers. Laplace, investigating the law of probabilities, suggested that the methods of observation and calculation might be of service in social and intellectual studies. The second astronomer, Quetelet, was the real founder of social physiology. Since his investigations there has been no doubt of the practicability of studying, by the methods of natural research, those social phenomena which had previously been only looked at through the telescope of speculation; for he, not contented with mere suggestions, made actual analyses of civil society; instituted mathematical investigations with groups of vital phenomena, to which only a few before him had ventured to apply the measuring-rod; showed the regularity of the formation of the social body and of its vital manifestations; and made apparent the close relations of cause and effect in the apparently voluntary acts of men in society. The followers on Quetelet's lines during the last thirty years have been very numerous. A whole school have adopted exactly his spirit and methods; others have worked analytically; and others have endeavored to build up a metaphysical sociology. The literature of many nations, particularly of England, Germany, France, and Italy, has now a legion of works aiming to investigate the phenomena of social life from the most diversified points of view, tenable and untenable; they differ widely in character, but all agree that the laws of human social phenomena are a legitimate subject of study. The mathematical method has been vastly aided during the same period by the operations of the statistical bureaus that have been established in most civilized countries, in collecting and classifying facts, which, with the averages they afford, are to the social philosopher what his chemicals, microscopes and instruments of precision, and his experiments, are to the natural philosopher.

The great progress which has been made in the comprehension of the principles of social philosophy is due to the method which has been adopted of laying aside for a time the consideration of single things and individuals in society and viewing it as a whole. The aggregate of those hundred thousands or millions of men which we call a people, a nation, or a society, forms, when regarded as if from without, a higher unit, in which the willing, transitory individual disappears and no longer exerts a disturbing influence on the observation of the great average. The society as an organization, not the individuals in themselves, is thus the object of social physiology. We can give such descriptions of society as a whole, of its structure, form, connections, and other peculiarities, as the mineralogist or the chemist, the botanist or zoölogist gives of matter and plants and animals; which are just and useful for a time, and form the descriptive or anaomical part. We can, too, further observe the organic functions of society as such, and deduce laws of cause and effect which are also available for a time as physiological laws—for a time, but not for always; for, quite in accord with more recent natural research, which endures no pause, but is always in movement and in a state of evolution, is a constant process of change exhibited in the circumstances of human society, without our meeting, on account of it, any contradiction with the principles from which we may have started.

We may describe social phenomena as vital and physical, and as ethical and psychical.

In order to obtain a proper position for deducing the general laws of social phenomena, it is necessary to overlook for the moment all concrete personality or individuality, and to regard, say, all the forty-five million inhabitants of the German Empire, or all the Germans in Europe, only as parts of a great whole, of a grand aggregate, describable under the name of a social body. We must imagine these men as in so close a reciprocal connection that, like the cells of a plant or animal, we can not conceive them as dismembered, but must regard them as forming by their union a single organism, a society, or a state. As in plants and animals each group of cells has its particular functional distinction, so here we meet groups of men among the millions constituting the whole, performing different parts in the common structure. One group will be engaged in material labors, another in the intellectual labors of religion and instruction; others in pursuits of art, science, jurisprudence, law, or the æsthetic development of the organism, and so on in an infinite diversity of adaptations, as among the parts of single living beings. Such a vision could be obtained in perfection if, as Huxley has imagined, one were an inhabitant of another planet, come to take a view of the whole earth and its inhabitants from some convenient distance where he could include the whole at a single glance. As we approach the realization of such a view, we gain a marvelous comprehension of the regularity of the types of masses of men, and of their normal composition and common properties. Take the sexual division of mankind. Although over the whole earth a general equality in the numbers of the two sexes prevails, nevertheless each land has its peculiar, apparently constant characteristic sexual composition. In Europe there anciently and still is a greater excess of women in the north than in the states of middle Europe and the east, in some of which the women are in the minority. Through Europe as a whole the number of women is very definitely in excess of that of the men, and the excess appears to be increasing. It was very great after the Napoleonic wars; then the numbers gradually tended toward equality and nearly reached it (1847 to 1850, 1,009 to 1,000); then they diverged again, and stood, in 1870, 1,037 to 1,000. The phases of increased difference are generally observable after wars, and latterly appear to be the result partly of the enormous emigration which has taken place to other quarters of the earth. In America as a whole, and in Australia and Africa, on the other hand, whither this emigration with its preponderance of males is tending, the men are in excess, and the excess is increasing with the constant arrival of new parties of immigrants. Nevertheless, a near approach to equality prevails over the earth as a whole, and this whether we regard the white, black, or red races, or their mixtures.

Another instance of typical regularity of structure is seen in the constitution of society by ages. Each country has its characteristic peculiarities in this respect. In France, for example, the percentage of children is the smallest, and that of men of from forty to sixty years, and of old men, is the greatest; while in the United States the exact contrary rules. European states generally lie between the two extremes, and present constant normal figures. The age-constitution of each country might be represented by a pyramid, the base of which should be made up of the class of the youngest, and the summit of that of the highest age. Such pyramids would have their particular proportions for each country, which would suffer only gradual changes through the continual operation of social and political influences. The pyramids standing for the United States and Hungary would have very broad bases, and rise by much sharper angles to their tops than those for France, Belgium, and the Netherlands, where children are relatively less, and middle-aged and old men more numerous.

A similar constancy is observed in respect to civil condition. Except in France—where the proportion of the married is greater and that of the single is less—of the whole population of all ages in the several European states, and with but little variation in any single state, sixty-two per cent of the male and fifty-nine per cent of the female inhabitants are single, thirty-four and thirty-three per cent are married, and six and eight per cent are widowed. Taking only that part of the population between forty-one and fifty years of age, with similar constancy, seventy to eighty-four per cent of them are married. Similar constants have been established with reference to religious confession, nationality, the choice of occupations, and other features and habits of different nations, but we pass to the consideration of a few special qualities. We are accustomed to distinguish our friends and acquaintances by their individual peculiarities, and we think we find very marked differences between them. Every man has his peculiarities of stature, girth, weight, color of hair, skin, and eyes, proportion between his limbs, strength, and pulse, but they all disappear, as Quetelet and others have shown, in the aggregate. The margin of variations in the individual traits of men is shown, by the measurements which these authors have applied to large groups, to be really very small. Among large masses of the population of a land as a whole, we find the same relative proportions of large, small, and middle-sized men, and constant relations in the number of thin, delicate, and bandy-legged persons, Falstaffs, strong and weak, quick-tempered and cool-blooded. The same is the case with the color of the hair, eyes, and skin, as Virchow has shown in Germany and Bertillon in the schools of France. Such a constancy in these traits has been shown on all the points hitherto inquired into, that we are able to draw similar conclusions on questions of race and nationality from these anthropological researches to those which the geologist deduces from the strata concerning the age of the formation.

Even those afflictions which we regard and lament as purely casual visitations on some families, such as blindness and deaf-mutism, exhibit a remarkable constancy of prevalence in whole societies. It may be a sufficient illustration of this to mention the striking fact that several computations of the number of persons suffering from these defects in Austria-Hungary and the German Empire, made independently of each other, at different times, and in different ways, have given the same numerical results; and that the numbers in other states are curiously near to those in the two mentioned, often differing only by a decimal. Although there are groups of states in which somewhat different ratios prevail, the frequent recurrence of the same average per ten thousand inhabitants, in a whole series of states, and for different decades in time, justifies the assumption that some law of proportion prevails, and forbids our supposing that the number is merely an affair of accident. On the basis of a number of coincidences of this kind, Quetelet constructed his ideal of the "average man," as a general standard by which to estimate the conforming proportion of the aggregate, and compare the individual with the type.

From the natural peculiarities, from the compositional structure of social bodies, we go a step further to their vital activities, their real physiology. Henceforth we may consider the curious variances in human generations, formerly regarded as accidental and voluntary combinations, as subject to a strict law. Within the circle of our acquaintance are childless families, and families that are blessed with hosts of children; families with all boys, and families with all girls; some strangely assorted marriages; men of extraordinary age, while we may remember other men who have died in the flower of their youth. All these things seem to us accidental and unaccountable; but social physiology shows that they, as well as other human movements, are governed by fixed and irrevocable laws.

We might expect some regularity in the rates of births and deaths, for these are necessarily conformable to the laws of Nature; but there is something to cause surprise in the fixedness of the rates, and the regular grouping of the various conceivable cases. It is also a curious fact that not only do a certain number of children come to each population year after year, but that the nativity figure also forms a characteristic trait of individual nations, and that in any particular course of years, when the regularity is not disturbed by any external cause, like a war or an epidemic, it hardly varies by a decimal part. This regularity extends even to the proportion of those who are born of either sex, the general average of which is expressed by the numbers—100 girls to 105·38, or, including still-born, 106·31 boys; and if this proportion is disturbed in any one year, it is almost certain to be made up in the following year.

International statistics show also a remarkable steadiness in the proportions characteristic of different countries of legitimate and illegitimate births, of quick and still-born, of twins, triplets, etc., which the complications often prevailing in the combinations only bring more clearly to light.

The same regularity is manifested in the death-rates, in which, whether we take long or short periods of time, the deviations from the fixed average are very slight; and all the acquisitions of modern civilization, with the great improvements that have been made in medical science and its applications, have not yet effected a material prolongation of the average of human life.

If any fundamental social fact is voluntary it is marriage; yet the ratio of marriages to the population is in most countries even more constant than that of deaths. The same regularity prevails in the peculiar features of the marriages; the same proportions of the marrying pairs are constituted of both single persons, widows and bachelors, widowers and spinsters, or both widowed. A curious uniformity prevails in the matter of disparity of ages, and other exceptional features, and finally of separations and divorced persons, of second, third, and more numerously repeated marriages. Each country has its own times of year or months when the most marriages take place. They are February and November in France, Austria, and Italy; May in Holland and Belgium; November and December in Sweden and Norway; and the fewest marriages take place in March, July, and August in France, Italy, Belgium, and the Netherlands; in August and December in Austria.

The intellectual qualities of a people do not lend themselves to measurement so readily as do the concrete peculiarities we have noticed. There are, however, a few criteria within our reach by means of which we are enabled to judge with some approach to exactness of the extent of the range within which the average standards of these qualities vary. The criteria are afforded by intellectual defects and aberrations, such as insanity, idiocy, the mental disorders arising from certain physical diseases, criminality, and the propensity to suicide. The information given by the statistics of the circulation of newspapers, letters, and telegrams; the results of the examinations of schools and for the military service; and even the statistics of misdirected letters, are all made of service in this investigation. They exhibit a tendency to uniformity which, although it does not always appear as marked as in respect to some of the qualities that have been considered, is nevertheless real. It is particularly striking in the case of suicides, concerning which Morselli has published very complete and minute statistics.

There need be no real difficulty in showing that the freedom of will and action which we accord to human beings and societies is consistent with subjection to the laws of social physiology. While we have not sufficient physical vigor to live more than a certain number of decades; while we are restricted in our scientific and artistic efforts by the capacity of our brain and nervous system; while we are preponderantly subject to the influence of the intellectual, political, and social currents of the age; while we are dependent on our geographical situation, on climate, soil, and the price of food—it is not yet necessary that we should be deprived of the attribute of free will. The laws of social physiology, although they have been deduced by observation as laws of Nature, and have suffered modification only through a short evolutionary epoch as compared with that through which the laws of Nature have subsisted, give nevertheless sufficient room for individual development. Because in the whole social body only the final results appear of the endless diversities existing within it, the freedom of individuals is consistent with the regularity of the whole. This whole, moreover, is itself not a stationary or rigid body, but an organism that is giving itself specific cultivation, and is continually suffering change, metamorphosis, and further development. An entire civic society can, by its collective will, modify, within the limits imposed by natural laws, all those properties and laws which we have discovered in the domain of social physiology.—*Translated and condensed from the Deutsche Rundschau.*

Dr. Alfred Russel Wallace acknowledges that the Americans possess, in respect to educational institutions, some special advantages over his own countrymen. They are comparatively free from Old-World establishments and customs; are not afraid of experiments; and seek, in whatever they undertake, to have "the biggest thing attainable." These features are manifested in some of the great American museums, "which rival, in certain special departments, the long-established national museums."

THE CHEMISTRY OF UNDERGROUND WATERS.

By Professor G. A. DAUBRÉE,
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TO understand the chemical composition of subterranean waters, we must inquire anew of the geological constitution of the country, and it will usually answer with precision and certainty.

Water does not have to remain long in the soil to dissolve and remove various substances from the rocks. Chemical analysis has already shown that such substances exist in the water-sheets of alluviums in more notable proportions than in the neighboring rivers. The difference is sufficient to explain why in Hungary, Egypt, India, and China, river-water is preferred to well-water for culinary uses. In the subsoil of inhabited places, water is not charged with mineral substances only; but the liquids of manure-heaps and other elements of corruption are transmitted to it by sewers, factories, and cemeteries. The unhealthy effect of the impurities thus conveyed to the wells has been frequently recognized; and it would be surprising if water exposed for centuries to such infiltrations did not cease to be potable.

The most common bodies found to be contained in subterranean waters are oxygen, nitrogen, and carbonic-acid gases, chlorides, carbonates, silicates, and sulphates of lime, magnesia, and soda, and organic substances, in the presence of excessive proportions of which water may cease to be drinkable, or even fit for domestic uses.

Water sometimes acquires also useful properties during its subterranean course. Springs which are employed as therapeutic agents are endowed with mineral qualities. The name of mineral is sometimes extended to other springs the high temperature of which makes them susceptible of similar uses, even when the amount of foreign matter they contain is inferior to what is included in many potable waters.

Chloride of sodium, or sea-salt, is sometimes present in so feeble proportions as not to be perceptible to the taste. It is derived from very widely distributed rocks, which contain traces of it. In other springs it exists in much stronger proportions. Such springs derive their salinity from beds of rock-salt, which it has been found profitable to mine or bore for directly.

Gypsum is dissolved in water under similar conditions. It is present in large masses and in a very fine state of division in the Parisian Tertiary beds, and, being freely soluble, gives hardness to many springs. It is often associated with other substances, which give therapeutic qualities to water, as in the cold springs of Contrexeville and Vittel in the Vosges, and the hot springs at Agovie and Schinznach in Baden. The mineralization in these cases is due to the presence of the soluble sulphates of lime and magnesia, which are furnished by the gypsiferous beds and dolomites of the Trias. At Birmenstorf the natural leaching of the gypsum rocks is imitated artificially; and either salt is dissolved according as it predominates in the particular stratum on which the process is performed; so that two kinds of medicinal waters are prepared. The purgative springs of Sedlitz, Seidschütz, and Püllna in Bohemia, derive their sulphate of magnesia from the Tertiary marl which they have traversed; and, this fact once recognized, similar waters have been produced for half a century by washing the rock—an experiment which was the starting-point of the artificial mineral-water industry. The origin of most of the sulphureted waters, or, to speak more exactly, of their sulphuret of calcium, is explained by the facility with which the sulphates can yield their oxygen to organic matters; a thing which occurs notably when carbonaceous matters, lignite, stone coal, or bitumen, are found associated with gypsum.

The origin of gaseous or acid springs, which constitute one of the most important families in a hygienic aspect, is connected with exhalations of carbonic acid, which are in turn one of the most remarkable phenomena of the globe's interior economy. The emanations of carbonic acid, as well as the springs to which they give character, are most commonly grouped near volcanoes, active or extinct, and ancient volcanic rocks, basalts, and trachytes. The granitic table-land of central France, in the chain of the Puys, as in the masses of Mont-Dore, the Cantal, and the Vivarais, exhales daily torrents of the gas, either dry or in solution, from more than five hundred springs. There are Royat, with its tumultuous ebullition, Saint-Allyre at Clermont, Saint-Nectaire, where all the oozings of the ground, even the road-ditches, boil with gas. Disengagements of carbonic acid are frequent in the mines of Pontgibaud, which are situated on the side of a crater and an ancient lava-flow, and where veins of silver-bearing lead-ore furnish conduits for the asphyxiating gas.

Countries where the volcanic rocks do not appear on the surface, but which are broken by deep dislocations, may also be the seat of exhalations of carbonic acid. The gaseous springs of Pongues, and some others of the Niévre, are situated upon simple faults. In northern Germany, on the left bank of the Weser, the country is riddled with fractures which give passage to abundant disengagements of carbonic acid, especially upon the plateau of Paderborn, and in the neighborhood of Pyrmont, Disburg, and Meinsberg. Acid springs occur under nearly the same conditions of stratification as the warm springs of which we are about to treat; and, like them, they reach the surface with the assistance of quartz or other mineral veins.

Sometimes the carbonic acid is abundant enough to make the waters in which it is incorporated spurt up violently; as at Montrond, Loire, where the intermittent eruptions from a depth of five hundred metres attain a great height; and at Nauheim, in Vétéravie, where a column of salt water has been spouting for forty years. As a counterpart to these phenomena of solution, waters form deposits which are interesting for more than one reason. Reaching the open, thermal and gaseous springs meet conditions of pressure and temperature different from those which ruled in the depths, and are consequently subjected to reactions to which the oxygen of the atmosphere frequently contributes. The deposits which they make are observed chiefly on the surface of the ground.

Lime, which is very abundant in the condition of a carbonate, is always in solution, in small quantities at least, and in larger quantities when free carbonic acid is present to assist the process. The conditions which provoke the disengagement of the gas at the same time determine the precipitation of the calcareous salt ; and this is why calcic carbonated waters often give rise to important deposits. The ancients were impressed by the stalactites of caverns, and by petrifying springs which covered plants and other bodies immersed in their basins with a stony precipitate. Industry has profited by the property, and has obtained in petrifactions bas-reliefs and images of a very delicate molding. In many places the deposit has become extensive enough to constitute a rock formation like the travertine at Tivoli, which furnished building-stones for Rome.

Silica, although regarded as insoluble in water, may become associated with it by the aid of intermediate agencies, and form combinations which are even the predominant elements of some springs, as at Plombières, Bagnères-de-Luchon, Ax, Saint-Sauveur, and Amélie-les-Bains. Sometimes silica is so abundant that it is isolated as opal on coming in contact with the air. The basins of many geysers are thus carpeted with it.

Iron-ore, or limonite, is also constantly in formation in such quantities that the beds can be worked. It is known, according to the conditions under which it is deposited, under the names of bog-ore, field-ore, or lake-ore. It is generally buried at slight depths below the surface, forming thin beds. Its modern origin is demonstrated by the presence of products of human industry, such as fragments of pottery and utensils, which are met in the massive blocks ; and it is, moreover, sometimes renewed in places where it has recently been worked. More than a thousand lakes in Sweden, Norway, and Finland supply this mineral in rounded and separated globules. Although its formation is in constant continuation, the cause of it has been for a long time misapprehended. It is a result of slow dissolutions which have been frequently observed in arenaceous clays. Rain-waters traversing them, having seeped along roots undergoing decomposition, take from them an acid principle, and thus acquire the power of dissolving oxide of iron as they go. Reappearing in the air, they abandon the hydrated peroxide of iron, leaving it as a brown, gelatinous precipitate. Organic substances in this way contribute to the formation of mineral matters.

According to recent investigations, the almost boiling Steamboat Springs in the United States precipitate, besides sulphur, small quantities of gold, mercury, silver, lead, copper, and zinc, which, by the aid of certain salts and their high temperature, they hold in solution. These deposits appear to be the continuation of those which in the same region, as at Sulphur-bank, have formed beds which are mined for their mercury.

What we have been able to observe from the surface of the ground gives a very limited and imperfect idea of the actions which excavations made to secure some particular thermal waters have revealed to us. The bottom of the basin of the principal spring at Bourbonne-les-Bains, where the temperature reaches 68° C., has furnished some very remarkable facts relative to the formation of minerals. The place was a flourishing station in the Roman period. In draining an ancient well a blackish mud was reached which contained fragments of wood, acorns, thousands of filberts which had become black like lignite, and numerous medals. The washing of four cubic metres of the mud yielded more than five thousand pieces of money, mostly of bronze or tin, but some of silver and gold. The four coins of the last metal bore the images of Nero, Hadrian, Faustina the younger, and Honorius. Twenty of the silver pieces belonged to the Gallico-Roman period, while the other coins were consular or imperial pieces, mostly of the first centuries of the empire; but some were as recent as the Lower Empire. The bronze pieces of the medium and smaller sorts were likewise of different ages, but three types of Augustan coins predominated. Many of them had been cut in two, doubtless to prevent their being taken out and used again, they having been cast in as offerings to the health-giving fountains. *Ex-voto* offerings were also recovered, including a bronze statuette of a man whose leg had been hurt.

Some of the coins had been so corroded by the action of the hot water that the figure on them could not be discerned. Others had been further corroded into holes and notches. Many others had been wholly dissolved, but had engendered, at the expense of their bronze, new and solidly agglutinated combinations. The species thus originated were identical in their crystalline forms and general characters with similar natural minerals—sulphuret of copper, copper pyrites, and variegated copper-ore. The most numerous crystals are regular tetrahedrons, like those of the mineral called gray antimonial copper, of which they have also the composition, the luster, and other properties. In some of the coins the tin of the bronze has passed into the state of an oxide, and has formed a white superficial crust. A real separation has therefore been produced between the metals of the alloy by the different workings of their chemical affinities. It seems as if in all of these transformations Nature, claiming her rights upon what human industry had taken out of her domain, had been pleased, with the aid of the mineral water, to recover her property, and reconstitute exactly the ores of copper and tin which the miner's operations had taken from her, and from which the furnaces of the metallurgists had laboriously extracted the two metals of bronze.

Lead pipes, of which there were a great number in connection with a white marble piscina, had suffered a no less energetic alteration. They were deeply corroded and perforated, and had by solution formed minerals with bases of lead—the sulphuret, or galena, and the chloro-carbonate, or phosgenite.

Among the iron compounds the bisulphuret, or pyrites, is of special interest, on account of its abundance in the crust of the earth. At Bourbonne, and in the basins of other thermal springs at Aix-la-Chapelle, Bourbon-Lancy, Bourbon-l'Archambault, and Saint-Nectaire, pyrites has been detected in course of formation, but only in the deeper parts of the basin remote from atmospheric oxygen.

In view of these changes, wrought by thermal water on inorganic bodies, it is not surprising that the same agent should also act upon organic bodies. The wood of the piles supporting a masonry-work, while it has perfectly preserved its texture, has become hard and heavy with the mineral matter which it has absorbed. The original substance has almost disappeared, and given place to carbonate of lime, which has penetrated, as the miscroscope shows, to the most minute interstices of the vegetable cells.

These springs of Bourbonne have given rise, within a very limited space, to not less than twenty-four species of crystalline minerals, in combinations which, accumulated and grouped as they are, closely resemble the ancient metalliferous beds—in detail as well as in general.

Other evidences of the mineralizing power of thermal waters have been exhibited in their operation for considerable distances below the surface of the ground. Penetrating the subsoil at Plombières, they have since the Roman period engendered a series of species no less remarkable than the preceding series, although they did not attract attention by a metallic luster; they are silicates of the zeolite group, opal, and chalcedony. When we try to apply the experimental method to the reproduction of geological phenomena, we are met, among other difficulties, by the brevity of human life, which is very short in comparison with the immense periods which have presided over the formation of the crust of the earth. Such facts as these, fortunately, make up for this inability, and put us in the presence of experiments that are forbidden to our laboratories, from which we learn what can be effected by very weak actions prolonged through ages. By these synthetic demonstrations, carried on during twenty times the duration of human life, Nature teaches us that she is still employing processes similar to those which she used in the most remote epochs.

We come now to see how subterranean waters obtain a heat which makes them thermal springs, and which connects them by intermediate agents with volcanic phenomena that are still, at first sight, so different and almost contrasted. The temperature of springs is generally nearly equal to the mean temperature of the ground from which they issue. But there are some exceptions to this usual condition, which are called thermal; a term which should be applied, not only to waters manifestly hot or warm, but also to those which by thermometrical indications differ by only two or three degrees from the normal temperature. Thermal springs are not always, therefore, distinctly separated from ordinary springs.

The extreme variations of temperature which we feel so vividly, according to the seasons, penetrate the ground very slowly and gradually subside, till they become insensible at a depth which is measured at Paris as of about twenty-five metres. Below this stratum of invariable temperature, the heat gradually increases as we descend; a fact which is not confined to temperate regions, but has been observed in countries near the equator and near the poles. It has been demonstrated by observations made in mines, in tunnels, and in artesian wells.

It is evident that this internal heat can not emanate from the sun nor from any cause exterior to our globe, for, if it did, it would not increase as we descend. It appears to be the resultant and continuation of the heat through which our planet has formerly passed. In radiating toward the celestial spaces, which are colder than anything of which we know, the outer masses are necessarily consumed first, while the heat continues intense in the central masses. In consequence of this general increase of heat, there are present in all parts of the interior of the globe, even far away from active volcanoes, rocks, contact with which heats water in a greater or less degree.

We have now to examine the various ways in which the structure of the rocks permits water, after it has descended to great depths, to return to the surface. The simplest way is by a turning back of the strata. The water of the artesian wells of Paris has been forced, having entered at the outcrops of the beds, to descend, between impenetrable strata, to a depth of which it has taken the temperature. The existence of a vast thermal bed under a part of the north of France would not have been revealed without the borings which have opened a way of return to its waters. But if the strata to which we refer, instead of being disposed in a vast concave basin, are subjected to a bending which would bring them up again to the surface, their thermal water would return with them, as if drawn through a siphon. This is the kind of a disposition which Nature has made real in countries where the strata have been bent under strong mechanical action. Such a structure may be recognized in the cases of the springs of Barbotan, Baden, Schinznach, Aix-la-Chapelle, Bercette, and in the Appalachian Mountains in Virginia.

Another mechanism of Nature, yet more closely resembling a siphon, is furnished by the large, nearly vertical fractures called faults, which descend to an indefinite depth, far below any point which it is possible for us to reach. Generally, they serve only for the direct descent of waters which, having been swallowed into them, find a little farther down an outlet from which they issue still cold. But it also happens, and the fact should be kept clearly in mind, that a fault offers a return route to water which has been heated at great depths. This is the case at Bourbonne-les-Bains. In the Alps, according to M. Lory, the same fault feeds the thermal springs of Monestier, Briançon, Brides, and Salines near Montiers. The fault which cuts and terminates the chain of the Alps near Vienna in Austria is the emissary of a considerable number of springs. Most of them are cold; but some hot springs, as those of Baden and Vöslau, are ranged along a distance of eleven kilometres.

The return branch of these natural siphons is often filled up and obstructed by incrustations which the water has formerly made, so as to form metalliferous veins. If the obstruction is not complete, or if it has been opened by mining excavations, these veins may be still serving for a way of ascent. A passage pierced at Plombières some thirty years ago in the granitic flank of the valley for the regulation of the warm waters, cut several veins of quartz and fluor-spar, along the sides of which springs gushed out forcibly. A similar incident took place at Lamalon, in Hérault, where it became necessary to stop the working of the veins of copper and lead, in order not to compromise the existence of the thermal establishment, the source of which was only a few dozen metres away. In the Comstock lode torrents of water having a temperature of 158° Fahr. gave out such heat that the workmen had to use ice to cool their shafts; and after twenty years of most profitable operation the mines became the object of great expenditures to obviate this difficulty.

It is for the most part in the neighborhood of extinct volcanoes and rocks of a volcanic nature that faults produce thermal spoutings. While such springs are usually wanting in the greater portion of the French central granitic plateau, they abound in those regions of the same plateau which are traversed by volcanic rocks.

There is no reason, therefore, to be surprised at finding the region of active volcanoes itself rich in emanations of this kind. Puzzuoli, Baiæ, and the baths of Nero, are situated near the solfataza of Puzzuoli and the ancient craters of Agnano and Lake Avernus. On the island of Ischia, as at Guadeloupe, the hot waters gush copiously from the flanks of the volcanoes.

We also observe near volcanoes boiling water violently projected into the air by torrents of vapor. The noise they make, which is like that of a steam-boiler, has caused the name of "Steamboat Springs" to be given to a group of this kind in the State of Nevada. Such springs are in close analogy with others in which the water is forced up, in the shape of a tall column, by intermittent eruptions. The latter have received the generic name of geyser, from the Icelandic word signifying *to spout*. One of the most remarkable geyser regions in the world is in the western part of the United States, near the borders of Wyoming Territory, where are grouped together more than two thousand very hot springs, which we might imagine to have been engendered by some vast steam-furnace.

Waters may also acquire a high temperature by borrowing from eruptive rocks which have been thrown up from greater depths and still retain a part of their primitive heat. They generally rise by the force of hydrostatic pressure, as in the artesian wells, while the expansive force of vapor is sometimes the elevating agent. Volcanoes, the eruptions of which suggest only the idea of fire, constitute, in fact, gigantic intermittent springs of water, the temperature of which surpasses everything that we can comprehend.

Thus, the vapor of water not only forms the most abundant and most constant product of eruptions, but it seems even to be, through its enormous tension, the mother of them. From the very beginning of the crisis it bursts out in enormous spurts, dragging matter of every kind up the subterranean conduit. This vapor produces a vertical column which spreads out in the upper regions of the atmosphere in the shape which in Italy Pliny has compared to that of a pine-tree. It is sometimes blackened, especially at the beginning of an eruption, by solid dejections of cinders or lapilli. The watery column may reach a considerable height if it is not carried away or dissolved by aërial currents. Torrential rains frequently fall from the clouds engendered by these exhalations.

Impossible as it may appear, water is incorporated in fused and incandescent lavas, and consequently participates in a temperature exceeding 1,000° ; but when it is vaporized its temperature falls at once to the boiling-point.

The water expelled from volcanoes gives only a very limited idea of the importance of the domain of that fluid in the depths of the earth. When we consider how many opportunities it finds to penetrate by capillarity and other means into interior regions of a very high temperature, we can not doubt that these regions contain superheated water. Imprisoned within rocky walls that offer an enormous resistance, it acquires a tension which recent experiments show to be of marvelous power.

Water also contributes invisibly to mechanical actions. In view of the immense force it exhibits in eruptions, we have a right to suppose that in regions where it has no outlet it may, under the force of its enormous pressure, be also an effective cause of the most formidable earthquakes, which are simply volcanic eruptions without outlet. These agitations are produced more especially in countries the ground of which is dislocated and has most recently acquired its present relief. Such a geological constitution, which is recognized as epecially connected with earthquakes, would have the precise effect of favoring the admission of water through its large fractures to deep and hot regions. Conditions of this kind are realized in all the parts of the basin of the Mediterranean which have been so frequently and violently agitated within historic times.

The facts that subterranean waters have thus taught us for the present epoch will aid in giving an idea of what they have effected in the extremely remote times of the geological periods. Minerals, which are their work, permit us to follow the track which they have left behind them through thousands of centuries.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE CAUSE OF CHARACTER.

IT may be taken for granted that almost everybody has a character, be the same more or less, good, bad, or indifferent, as the case may be. The exception, in fact, need only be made in favor of imbecile persons and idiots, who usually possess no character at all to speak of, or whose character is, at least, of a decidedly negative and uninteresting variety. Even those good people whom the uncompromising Scotch law describes with charming conciseness as "furious or fatuous," and delivers over to the cognizance of their "proximate agnate," must needs possess at least so much of character as is implied in the mere fact of their furiousness or their fatuity, as circumstances may determine. And furthermore, roughly speaking, no two of these characters are ever absolutely identical. The range of idiosyncrasy is practically infinite. Just as out of two eyes, one nose, a single mouth, and a chin with the appendages thereof, hirsute or otherwise, the whole vast variety of human faces can be built up, with no two exactly alike; so, out of a few main mental traits variously combined in diverse fashions, the whole vast variety of human character can be mixed and compounded to an almost infinite extent. To be sure, there are some large classes of mankind so utterly commonplace and similar that from a casual acquaintance it is hard to distinguish the individuality of one of them from that of the other: just as there are large classes of typical faces, such as the Hodge, the 'Arry, the Jemimer Ann, and the Mrs. Brown, which appear at first sight absolutely identical. But, when you come to know the Hodges and the 'Arries personally, you find that as one Hodge differs slightly from another in countenance, so do even they differ slightly from one another in traits of character and intellectual faculty. No two human beings on this earth—not even twins—are ever so utterly and absolutely alike that those who have known them familiarly for years fail to distinguish one from the other.

The problem of this difference of idiosyncrasy, indeed, is one so intimately bound up with all our ideas of our own origin and nature that it well deserves a few minutes' consideration at the hands of the impartial psychological philosopher. It has for each of us a personal interest and importance as well; for each of us wishes naturally to know how and why he happened to come by his own charming and admirable character. Yet, unhappily, while there is no subject on earth so interesting as ourselves (the one theme on which "all men are fluent and none agreeable"), there is none upon which the views and opinions of other people appear to us all so lamentably shallow and lacking in insight. They talk about us, forsooth, exactly as if—well, exactly as if we were other people. They bluntly ignore those delicate and subtile distinctions of idiosyncrasy which raise each of us, viewed with his own introspective eyeglass, into a class by himself, infinitely superior to the rest of creation.

Let us see how far we can gain any light from the doctrine of heredity on this curious question of the origin of character.

If a white man marries a negro, their children, boys and girls alike, are all mulattoes. Let us make to ourselves no illusions or mistakes upon this score: each one is simply and solely a pure mulatto, exactly half-way in color, feature, hair, and stature, between his father's race and his mother's. People who have not lived in a mixed community of blacks and whites often ignore or misunderstand this fundamental fact of hereditary philosophy; they imagine that one of the children of such a marriage may be light brown, and another dark brown; one almost white, and one almost black; that the resulting strains may to a great extent be mingled indefinitely and in varying proportions. Not a bit of it. A mulatto is a mulatto, and a quadroon is a quadroon, with just one half and one fourth of negro blood respectively; and anybody who has once lived in an ex-slave-owning country can pick out the proportion of black or white elements in any particular brown person he meets with as much accuracy as the stud-book shows in recording the pedigree of famous race-horses. Black and white produce mulattoes—all mulattoes alike, to a shade of identity; mulatto and white produce quadroon—all quadroon, and no mistake about it; mulatto and black produce sambo; quadroon and white give us octoroon; and so forth *ad infinitum*. After the third cross persistently in either direction, the strain of which less than one eighth persists becomes at last practically indistinguishable, and the child is "white by law," or "black by law," as the case may be, without the faintest mark of its slight opposite intermixture. I speak here of facts which I have carefully examined at first hand; all the nonsensical talk about finger-nails and knuckles, and persistence of the negro type forever, is pure unmitigated slave-owning prejudice. The child of an octoroon by a white man is simply white; and no acuteness on earth, no scrutiny conceivable, would ever discover the one-sixteenth share of black blood by any possible test save documentary evidence.

Here, then, we have a clear, physical, and almost mathematically demonstrable case, showing that, so far as regards bodily peculiarities at least, the child is on the average just equally compounded of traits derived from both its parents. Among hundreds and hundreds of mulatto and quadroon children whom I have observed, I have never known a single genuine instance to the contrary. Heredity comes out exactly true; you get just as much of each color in every case as you would naturally expect to do from a mixture of given proportions. In other words, all mulattoes are recognizably different from all quadroons, and all quadroons from all octoroons or all sambos.

This simple fact, I venture to think, gives us at once the real key to the whole complex problem of idiosyncrasy and character. Every child on the average represents one half its father and one half its mother. It is a Jones in this, and in that a Robinson. Here it takes after its grandfather the earl, and there it resembles its grandmother the washerwoman. These traits it derives from the distinguished De Montmorencies, and those from the family of the late lamented Mr. Peace the burglar. But, on the whole, however diversely and curiously the various individual peculiarities may be compounded, it is at bottom a Robinson-Jones, a complex of all its converging strains, its diverse noble and ignoble ancestors. It represents a cumulative effect of antecedent causes, all of which it shares equally on the average with every one of its brothers and sisters.

How does it happen, then, suggests the easy objector, that two brothers or two sisters, born of the same father and mother, twins it may even be, "are often more unlike each other in character and mental qualities than any two ordinary strangers"? Well, the answer simply is, it doesn't happen. Make sure of your facts before you begin to philosophize upon them. Children of the same parents are always very much like one another in all essential fundamentals; they may differ a good deal among themselves, but their differences are really and truly as nothing compared with the vast complexity of their resemblances. The case of twins, in fact, is a peculiarly unfortunate one to allege in this respect, for Mr. Galton has collected an immense mass of evidence tending to show that just as twins usually resemble one another, almost indistinguishably, in face and feature, so do they resemble one another almost as narrowly in character and intellect. I know an instance myself of two twin sisters, one of whom has lived all her life in India, and the other in England, but who, in spite of this difference in circumstances, preserve so entirely their original identity of form and nature that I do not myself in the least discriminate between them in any way, mentally or physically, though they happen to be members of my own family. It does not at all matter to me whether it was Polly who said a thing or Lucy. I regard it in either case as a simple expression of the Polly-Lucian shade of character. This is the rule in nine cases out of ten; twins are all but absolutely identical.

Still, there is such a thing as idiosyncrasy, and the reason for its existence is a very simple one. Each separate human being, it is true, is on the average an equal compound of his father and his mother, his grandfathers and grandmothers; but not necessarily or even probably the same compound. Suppose you take a lot of red and white ivory billiard-balls, say a thousand, and cast them down upon the surface of the billiard-board. Let five hundred be red and five hundred white; then every time the total result will be in one sense the same, while in another sense it will be quite different. For there will always be five hundred of each, but the arrangement will never be exactly identical; each throw will give you a new combination of the balls—a combination which will often put a totally different aspect upon the entire picture. Now, in the case of a human being you deal with infinitely more subtile factors, combined in infinitely more subtile fashions. Father and mother have each in their being myriads of traits, both mental and physical, any one of which may equally happen to be handed down to any of their children. And the traits handed down from each may not happen to be by any means always the same in the same family. Though each child resembles equally on the average both father and mother, yet this child may resemble the father in this, and that child in that; each may combine in any possible complexity of intermixture traits derived from either at random.

Here, for example, are an English father with light hair and blue eyes; a Spanish mother with black locks, an iris dark as night, and a full olive-colored southern complexion. Clearly, the children may differ indefinitely in appearance, some with darker eyes, some with lighter; some as men may grow dark-brown beards, and some may have black whiskers and hazel eyes, and clear half-Spanish dusky skin. One may have wavy hair like the mother, yet almost as light in hue as the father's; another may have it rather straight, but dark. Similarly, too, with the features. The forehead and chin may resemble the father, the nose and mouth may rather approximate to the maternal pattern. So, at least, we often say in our folly; but in reality, when we come to examine closely, we see that no single feature, even, owes everything absolutely to one parent only. Those dark eyes may indeed be Spanish in color, with a gleam of bull-fighting in their cruel depths, but they are set in the head after an English pattern, and have an English solidity of Philistine hardness. That pretty little nose may have much of the father in the bridge and the tip, but don't you catch faint hints of the mother, too, in the quivering nostril and the expanded wings? The chin recalls an Andalusian type, to be sure, but the tiny fold of flesh beneath foreshadows the fat double crease of later life derived from that old burly Lincolnshire grandfather. And so on throughout. Not a feature of the face that is not true at bottom, in one point or another, to both its ancestries ; not a shade of expression that does not recall in varying degrees some mingled traits of either parent.

The number of possible traits, then, are so immense, and the modes of their possible combination so infinite, that no two people, not even twins, ever come out exactly similar. Box and Cox are twain, not one ; the Corsican Brothers are known as a pair to their intimate circle. Nevertheless, brothers and sisters do, on the whole, closely resemble one another, and this we all of us instinctively recognize whenever we talk of a family likeness. These family likenesses are almost always far stronger, both in mind and body, than members of the incriminated family itself ever care at all to recognize. It often happens, for instance, that Fred and Reginald fail to perceive the faintest resemblance between their sisters Maud and Edith. But a stranger looking through the family album (poor victimized martyr) says to Fred, as he comes upon one of their photographs, "I'm quite sure that's one of your sisters, but which is it, Miss Maud or Miss Edith ?" Nay, I have even known a father himself mistake a portrait of Maud for Edith. The photograph obscured some external difference of tint or complexion, and therefore brought out in stronger relief the underlying similarity of feature and expression. It must have happened to most men to be mistaken for their own brothers by people who had never seen them before, though they themselves, looking complacently in the truth-telling glass, can hardly imagine how any one on earth could take them for such a fellow as Tom or Theodore. Tom's so very much plainer than they are, and Theodore looks so infinitely less gentlemanly. All round, in short, families resemble one another, and it is only after a considerable acquaintance with their minuter details that strangers really begin accurately to distinguish certain of their members. To themselves the differences mask the likeness, to outsiders the likenesses mask the difference.

It is just the same, be sure, in mental matters. There are family characters and family intelligences, as there are family faces and family figures. Each individual member of the brood has his own variety of this typical character, but in all its basis is more or less persistent, though any one particular trait, even the most marked, may be wanting, or actually replaced by its exact opposite. Still, viewing the family idiosyncrasies as a whole, each member is pretty sure to possess a very considerable number of peculiarities more or less in common with all the remainder. True, Jane may be passionate while Emily is sulky ; Dick may be a spendthrift, while Thomas is a miser. But Jane and Dick are both humorous, Emily and Thomas both musical, Thomas and Dick both sensitive, Emily and Jane both sentimental, and all four of them alike vindictive, alike intelligent, alike satirical, and alike fond of pets and animals. Look at the persistent Tennysonian tone in Charles and Alfred Tennyson; look at the parodying power of the two Smiths in "Rejected Addresses"; look at the Caracci, the Rossettis, the Herschels, and then say whether even minute touches of taste and sentiment do not come out alike in brothers and sisters. Almost everybody who meets brothers or sisters or cousins of his own after a long separation (when use has not dulled his apprehension of the facts) must have noticed, with mingled amusement and dissatisfaction, in ten thousand little ways and sayings how very closely he and they resemble one another. Sometimes the very catchwords and phrases they use, their pet aversions and their pet sympathies, turn out at every twist of life to be absurdly identical. One may even be made aware of one's own unsuspected and unobtrusive failings by observing them, as in a mirror, in the minds of one's relations, like King George's middy in Mr. Gilbert's story, who meets himself on an enchanted island, and considers his double the most disagreeable fellow he ever came across.

Why is it, then, that most people won't admit their own essential unity and identity of character with their brothers and their sisters, their cousins and their aunts? Vanity, vanity, pure human vanity, is at the bottom of all their violent reluctance. Every man flatters himself at heart that he possesses an immense number of admirable traits not to be found in any other and inferior members of his own family. Those spurious imitations may indeed resemble him somewhat in the rough, as coarse pottery resembles egg-shell porcelain; but they lack that delicacy, that refinement, that native grace and finishing touch of character which distinguish Himself, the cream and flower of his entire kindred, from all the rest of a doubtless worthy but very inferior family. I fancy I see you now—you, even you, my excellent critic—with that graceful cynical smile of yours playing lambent upon your intellectual upper lip, while you loll at your ease in your club armchair, and murmur to yourself complacently as you read, "The idea of identifying *me* with my brother Tom, for instance! Me, a cultivated, intelligent university man, with that stolid, stupid Philistine sugar-broker! If only I'd his wealth, how differently I'd use it! The notion's simply too ridiculous! Why, I am worth a dozen of him!" My dear sir, believe me, at this very moment your brother Tom, glancing hastily through the pages of the present paper in an interval of relaxation on his way home by Metropolitan Railway from his lair in the city, is observing with a corresponding calm smile of superiority to himself, "Ha, ha, what an absurd idea of this magazine fellow, to tell me I'm no better than my brother Jack, that briefless barrister! Jack, indeed, in the name of all that's ridiculous! If only, now, I'd had his advantages and his education—sent to Rugby and Oxford for the best years of his life, while I was stuck at seventeen into a broker's office to shift for myself and pick up my own living! And yet, what has my native talent and industry enabled me to do? Here am I at barely fifty a wealthy citizen, in spite of all my disadvantages, while he, poor idle dog, has never been able to secure as much as a brief, with all his learning! I'm fifty per cent a better man than he is!" Vanity of vanities, saith the preacher, all is vanity.

The fact is, if we want impartially to discuss this question of characters we must each leave our own supernaturally beautiful character out of the queston, and think only of the vastly inferior and ordinary characters of other people. We mustn't even allege striking instances from the history of our sisters, our cousins, and our aunts, because there, on the one hand, our calm sense of the excellence of the stock from which we ourselves are the final flower and topmost outcome is apt to prejudice our better judgment, while on the other hand our natural contempt for the gross shortcomings of our near relations under such closely similar circumstances, when compared with our own virtues and strong points, is liable to beget in us too lordly a superciliousness toward their obvious failings. It is best entirely to dismiss from consideration all the persons standing to ourselves within the list of prohibited degrees set forth in the Prayer Book, to abstain from too fond an affection for our grandmother, and to concentrate our attention wholly on the persons of that common vulgar herd of outsiders falling as aforesaid under the contemptible category of other people.

Examined from this impartial and objective point of view, then, other families beside our own show us at once how much light may be cast upon the origin of character by the study of fathers and mothers, brothers and sisters, first and second cousins, and so forth indefinitely. Mr. Galton's exhaustive paper upon the habits and manners of the common twin is an admirable example of the precise results that may be obtained by such minute and accurate objective study of hereditary peculiarities. For it must always be remembered that two brothers ought by nature to resemble one another far more closely than father and son. People often wonder why such-and-such a great man's son should not be a great man also; they ought, if logical, rather to ask why his brothers and sisters were not all of them equally great men and women. I will not insult the intelligence of the reader by pointing out to him why this should be—why the father's traits in such a case should be diluted just one half by the equal intermixture derived from the mother. For the same reason, of course, two sisters ought by nature to resemble one another far more closely than mother and daughter. Again, a son ought on the average to resemble his father in character somewhat more closely than he resembles his mother, because in the one case the identity of sex will cause certain necessary approximations, and in the other case the diversity of sex will cause certain necessary divergencies. The barber in Leech's picture explains his young customer's defective whiskers on the ground that he probably "took after his ma!" but experience shows that in such matters men usually "take after their pa" instead. Once more, for a similar reason two brothers will tend to resemble one another, time and again, somewhat more closely than a brother and a sister. Furthermore, the two elder children and the two younger will tend to resemble one another more, as a rule, than the eldest resembles the youngest, and for a very sufficient reason, because all the habits and constitution of the two parents are liable to change from time to time, and especially after a long interval of years. Hence it will follow by parity of reasoning that two brothers or two sisters, born twins, will tend to resemble one another on the average far more intimately than do any two other members even of the same family. The rationale of this is clear. They are both the children of the one father and the one mother; they are both of the same sex; and they are both born at the same time, and therefore under exactly the same conditions of age, health, habit, and constitution on the part of both parents.

Here, then, we have a crucial instance by which we may test the physical and psychical correctness of this our general *a priori* principle. If character results in the way I say it does—if it is a product of the interaction of two independent sets of factors, derived equally on the whole from father and mother—then it will follow that, mentally and physically, twins will far more closely resemble one another than ordinary brothers and sisters do. Now, does the case of twins bear out in actual fact this debated deductive conclusion? Common experience tells us that it does, and Mr. Galton has supplemented that fallible and hasty guide by the most rigorous inductive collection of instances. The result of his investigation is simply this, that many twins do actually behave under similar circumstances in almost identical manners, that their characters often come as close to one another as it is possible for the characters of two human beings to come, and that even where the conditions of later life have been extremely different, the original likeness of type often persists to the very end, in spite of superficial variations in style or habit of living. Some of his stories, carefully verified, are very funny. I will supplement them by two of my own. In one case a couple of twins, men, had a quarrel over a perfectly unimportant matter. They came to very high words, and parted from one another in bad blood. On returning to their rooms—they lived apart—each of them suffered from a fit of remorse, and sat down to write a letter of contrition to the other, to be delivered by the morning post. After writing it one brother read his letter over, and, recalling the cause of quarrel, added at once a long postscript, justifying himself, and reopening the whole question at issue. The other brother posted his note at once, but thinking the matter over quietly, afterward regretted his action again, and supplemented it by a second palinodia, almost unsaying what he had said in the first one. I saw all three letters myself the next morning, and was simply amazed at their absolute sameness of feeling and expression.

The other story relates to a fact which happened, not to twins, but to two successive brothers extremely like one another in build and feature, and evidently modeled in mind and character on the self-same mold. It is only a small incident, but as I can vouch for the correctness of the minute details, it has a certain psychological interest of its own. They met a lady dressed in blue, whom they had never seen before, at a military dance. Each of them asked at once to be introduced to her at first sight; each asked the same officer for an introduction (though they had several friends in common present); each described her in the same way, not as "the lady in blue" (the most obvious point of appearance about her), but as "the lady with the beautiful ears"; each fell desperately in love with her offhand; and each asked her for a particular flower out of a little bouquet containing four or five more conspicuous blossoms. Finally, each came up at the end of the evening to confide in the same married lady of their acquaintance their desire to see more of the beautiful stranger. Now, small as are all these little coincidences, they nevertheless show, to my mind, a more profound identity of mental fiber than far larger and more important matters of life could do. For, on great emergencies, or in the great affairs of one's conduct, it is only natural that somewhat similar characters, being governed by the same general emotions, should act on the whole very much alike; while often, on the other hand, a particular difference will make the action of similar characters at a special crisis extremely divergent. Thus the two Newmans, essentially the same in fiber, both re-examining their creed at a certain epoch of life, follow out their own logical conclusions with rigorous precision, one to Free Thought, the other to the Cardinalate—so that outsiders would be apt to say at first sight, "What a striking difference between two brothers!" But the exact identity of tastes and preferences shown in these minute touches of feeling—the choice of an introducer, the phrase about the ears, the selection of a particular flower (it wasn't even a violet, which might occur to anybody, but a spray of plumbago, in itself quite without sentimental interest), and the unburdening of mind to a particular confidante—all these things abundantly testify to an underlying similarity of mental structure, down to the merest side-tracks and by-ways of the brain, which could hardly happen under any other conceivable circumstances than those of actual family identity.

Still, even twins do distinctly differ in some things from one another. However much they may look alike to strangers, they are always discriminable by those who know them well, and even in early childhood by mothers and nurses. The babies who have to be distinguished by red and blue ribbons tied round their wrists, and who finally get mixed up at wash, so that the rightful heir is hopelessly muddled with the wrongful, and the junior by ten minutes preferred to his senior, belong only to the realm of the novelist; and even there we have always the well-known mark on the left shoulder to fall back upon, which invariably proves the genuine title-deed to the family estates and the hand of the heroine. But, in real life, Huppim may always be readily distinguished from Muppim by some slight divergence of feature or expression; Huz is always a trifle fatter or thinner than Buz, his brother; the two Dromios and the two Antipholuses may deceive the outer public by their close resemblance, but not even Shakespeare himself can make us believe that Mrs. Antipholus was really mistaken as to the personal identity of her own husband. I don't want to be too hard on a lady, but I fancy, myself, she was glad of the excuse for a little innocent and easily explicable flirtation with an agreeable stranger.

Yes, everybody has a character and an idiosyncrasy different in many points from everybody else's. Not even twins, who come closest together of all humanity, merge their individuality absolutely into mere replicas one of the other. Such utter identity is quite impossible in the human family. And the reason, I think, is simply this: the infinite number of separate traits possessed by each human being is too immensely incalculable ever to admit of any two throws, however near, producing precisely the same resultant. I do not doubt that there may be snails or jelly-fish built absolutely on the same pattern in every particular, mental or physical; though, even there, the man that knows them well is often astonished at the way in which one snail differs from another in aspect, or one jelly-fish differs from another in character and intellect. But while the papa snail and the mamma snail are distinguishable in a few traits only, discoverable by none but the close observer, the papa and mamma among human beings are distinguishable by ten thousand diverse peculiarities, mental and physical, all of them obvious to the veriest outsider. Each child is, as it were, a meeting-place and battle-field for these diverse paternal and maternal tendencies. It must resemble one or the other in every fiber of every feature; it can't possibly resemble both exactly in those points in which they conspicuously differ. Hence the resultant is, so to speak, a compromise or accommodation between the two; and the chances of the compromise being ever absolutely equal in any two cases are practically none. You might throw down the letters of the alphabet which compose "Paradise Lost" for ever and ever, but you would never get even one line by accident in the exact order that Milton wrote it. In the struggle for life between each unit or cell that goes to make up brain and face and nerve and muscle, here the father conquers, and there the mother, and yonder a truce is struck between them; but that any two among the children should ever represent exactly the same result of the desperate struggle is so infinitely improbable as to be practically impossible.

One last word as to the difficulty which some observers doubtless find in making this theory fit in with the facts as they observe them. While writing this paper, I paused in the midst, laid down my pen, and went from my study into the adjoining room for an intercalary cup of five o'clock tea with the members of my family. (After all, we are all vertebrate animals and human beings; why attempt to conceal the fact out of consideration for the dignity of literature?) The talk turned, as it often does turn under such circumstances, on the subject about which I had just been writing. I expounded these my views on the origin of character to the attentive ears of a critical domestic audience. To my utter dismay and discomfiture, I found that they of mine own household were firmly opposed to me. "Why," said the person, who, of all others on earth, ought to back me up most surely in my worst heresies, "look at So-and-so and So-and-so! You know they're twins; and yet how utterly unlike one another they are in character!" Now, will you believe me, as it so happened, So-and-so and So-and-so were two of the very cases on which I most relied in my own mind when making some of my present generalizations about twins and their identity! This, of course, conclusively shows that people sometimes differ in opinion. Some of us see differences more acutely, and some of us likenesses. To some of us the So-and-so family are all as like as two peas; while to others of us there is absolutely nothing common to all of them. Depend upon it, neither side is right; the So-and-so's are in some ways very much alike, and yet in other ways very different. The family face and the family character run pretty impartially through them all; but each wears it in his own fashion and with his own special combination of peculiarities. One side has a keen eye for the resemblances; the other has a keen eye for the differences. Mr. Galton's method, by taking the mean of many observations, effectually gets rid, so far as possible, of this little natural "personal equation."

A single example will make this matter clearer than pages of abstract argument could make it. One of the instances I cited above was that of two brothers so identical in fiber that each did exactly the same thing, at times, with exactly the same minute touches of feeling and expression. They recognized the absolute identity themselves; it was often to them a cause of some laughter, and not infrequently of some confusion and suspicion also. Each knew a trifle too well what the other was likely to do and think of. Yet I have on paper a letter from one of their acquaintances, saying, in so many words, "James has been staying here for some weeks; we like him very much, indeed, but oh, how different he is from *our* Mr. Trois Etoiles!" Now the fact is, that was probably the judgment of every one everywhere who knew them both only superficially. The younger brother, whom I have ventured here to call James, because James is a good solid Christian name, implying honest industry and business ability, had been put to work at his father's occupation early in life, and was known to most men as a quiet, sober, steady-going man of affairs. The elder brother, whom I will christen Percy, because the name Percy has a fine literary flavor about it, and suggests either Shelley or the reputed author of Aytoun's "Firmilian," according to the taste and fancy of the reader, had been sent, as the heir of the house, to Cambridge, and having there acquired the habit of literature, took to journalism and other reprehensible pursuits, and sank at last into a confirmed scribbler. The world at large always said that Percy was a very clever fellow, while that man James had absolutely nothing at all in him. His entire interest was absorbed in the tea-trade. We who knew them both well, however, could clearly discern that the mere difference of position and education masked in James the very characteristics that were plainly developed and abnormally nurtured in his brother Percy. And Percy often said to me in confidence, after eleven o'clock at night, as we sat together over our glass of whisky-toddy, "If James had only been sent to Cambridge, he'd have been a deal cleverer fellow than I am." It may have been rude of me, but I always agreed myself with Percy.—*Cornhill Magazine.*

SKETCH OF DAVID AMES WELLS.

DAVID AMES WELLS has long been the representative economist of the United States, and a thinker whose vast information, fearlessness, and thoroughly judicial mind, have won him fame among economists the world over. He has proved his ability and sagacity in the successful management of large business interests. While most economic teachers have been confined to class-room and text-book, it has been his exceptional good fortune to practically apply his science to the reform of fiscal errors. Since vacating his high office under the Federal Government, he has exerted wide and growing influence upon the legislators of the nation.

Mr. Wells was born in Springfield, Massachusetts, June 17, 1828, and is a lineal descendant on the father's side of Thomas Welles, Governor of the Colony of Connecticut, 1655–1658, and on the mother's side of David Ames, who, under Washington, built and established the National Armory at Springfield. He and his brother Oliver were the founders and progenitors of the well-known manufacturing and railroad-building family of Massachusetts. After graduating at Williams College in 1847, and writing and publishing his first book, entitled "Sketches of Williams College" David Ames Wells was for a time (1848) an assistant editor with the late Samuel Bowles of the Springfield "Republican." While thus employed, Mr. Wells suggested the idea, and was associated in the invention, of folding newspapers and books by machinery in connection with power printing-presses; and the first machine ever constructed and successfully operated was built at his expense and worked under his direction in the office of the "Republican." Having, however, a taste for scientific pursuits, and being now in the possession of some means through the sale of his interest in the above invention, he quitted the pursuit of journalism, and in 1849 entered the Lawrence Scientific School of Harvard University, becoming also at the same time a special pupil of Professor Agassiz, who had then recently arrived in this country. Graduating in the first class that completed a course of study in the Scientific School in 1851–'52, he immediately received the appointment of assistant professor in this institution and also that of lecturer on physics and chemistry in Groton Academy, Massachusetts. During his residence in Cambridge, Mr. Wells, in association with George Bliss (late United States District Attorney for New York), commenced in 1849 the publication of an annual report on the progress of science and the useful arts, which, under the name of the "Annual of Scientific Discovery," was continued for many years.

Between 1857 and 1863, Mr. Wells was engaged in the preparation of a series of scientific school-books, which at one time attained a very extensive circulation, two of the series having been translated by missionaries into the Chinese language, while a third—an elementary treatise on chemistry—was adopted as a text-book at West Point.

Mr. Wells, however, first came prominently into public life in 1864, while residing in Troy, New York, through the publication in that year of an essay on the resources and debt-paying ability of the United States, bearing the title of "Our Burden and Strength." This essay was first read at a literary and social club in Troy, then published privately, then reprinted and circulated by the Loyal Publication Society of New York, and, receiving at the same time the approval of the Federal Government, it became one of the most noted publications of the war period. It was reprinted in England and translated into French and German, and had a circulation which is believed to have been in excess of two hundred thousand copies. Coming at a period when the nation was beginning to be alarmed at the prospective magnitude of the public debt, and apprehensive of an impending crushing burden of taxation, its publication and circulation proved a most effective agency for restoring public confidence and maintaining the credit of the Federal Government.

The perusal of this pamphlet made a great impression upon President Lincoln, and in January, 1865, he sent for Mr. Wells to come to Washington and confer with him and Mr. Fessenden, then Secretary of the Treasury, on the best methods of dealing, after the termination of the war, then evidently at hand, with the enormous debt and burden of taxation that the war had entailed upon the nation. The result of this conference was the passage by Congress of a bill, in March, 1865, creating a commission of three persons for the purpose of inquiring into and reporting "on the subject of raising by taxation such revenue as may be necessary in order to supply the wants of the Government, having regard to and including the sources from which such revenue should be drawn, and the best and most effectual mode of raising the same." Of this commission, Mr. Wells was appointed chairman by the then Secretary of the Treasury, Hon. Hugh McCulloch; and its report in 1866, which was mainly the work of Mr. Wells, presented for the first time a full and exact statement of the curious and complex system of internal and customs revenue which had grown up during the war, when the necessities for raising immense sums of money with the utmost promptness and regularity were so great as to transcend all ordinary considerations, and justify the maxim, "Whenever you find an article, a product, a trade, a profession, or a source of income, *tax it.*" How wonderfully successful this system of taxation proved, is shown by the circumstance, that for the last year of its full operation —1865–'66—it yielded from internal-revenue sources alone $310,000,000, and from internal revenue, customs, and other sources, the aggregate sum of $559,000,000, drawn from a tax-paying population not much in excess of twenty-two millions. In addition to this feature of the Revenue Commission Report in 1866, it also contained elaborate reports on sugars, tea, coffee, cotton, spices, proprietary articles—patent medicines and the like—petroleum, fermented liquors, and distilled spirits as sources of revenue, with estimates as to the amount of revenue which the Treasury might expect if taxation on them, at various rates, was to be continued; the whole being really the first practical attempt in the United States to gather and use national statistics for great national purposes.

On the termination of the Revenue Commission in January, 1866, by limitation of service, Congress was so well satisfied with the work that Mr. Wells had performed, that he was immediately appointed, for a term of four years, to an office created for him, under the title of "Special Commissioner of the Revenue," the duties of which were thus defined by the enacting statute: "He shall from time to time report, through the Secretary of the Treasury, to Congress, either in the form of bill, or otherwise, such modifications of the rates of taxation, or of the methods of collecting the revenues, and such other facts pertaining to the trade, industry, commerce, or taxation of the country as he may find by actual observation of the operation of the law to be conducive to the public interest."

In this office, and invested with large powers, Mr. Wells entered with ardor upon the work of reconstructing and repealing the complex system of internal taxation, which had become terribly oppressive, and the longer continuance of which had become unnecessary; and, under his initiation and supervision were originated nearly all the reforms of importance in our national-revenue system—internal and customs—that were adopted by Congress between the close of the war in

1865 and the year 1870, namely: the redrafting of the whole system of internal-revenue laws, the reduction and final abolition of the cotton-tax, and the taxes on manufactures and crude petroleum; the creation of supervisory districts and the appointment of supervisors; the origination and the use of stamps for the collection of taxes on tobacco, fermented liquors, and distilled spirits, and the creation of the Bureau of Statistics. To the head of this Bureau Mr. Wells called, from the office of the Springfield "Republican," its assistant editor General F. A. Walker; and under his management the Bureau was first efficiently organized.

In one of his earliest official reports, Mr. Wells took earnest ground against the attempt to collect a tax of two dollars per gallon, or 1,000 per cent on the first cost, on distilled spirits, and maintained that fifty cents per gallon was the rate of tax certain to be the most productive of revenue, and little oppressive to manufacturing industries. This report, made in 1866, although attracting much attention, by reason of its detailed narration of the singular experiences of the Government in attempting to enforce so high a tax, found little favor in respect to its recommendation for tax abatement. But, in the winter of 1867–'68 Congress, becoming alarmed at the increasing frauds, and steadily diminishing receipts of revenue, acceded to Mr. Wells's recommendation and fixed the tax at fifty cents per proof gallon. The result was one of the most remarkable in all economic or fiscal experiences, for the total collections rose at once from $18,665,000 during the last year of the $2 tax in 1867–'68, to $45,071,000 in the first year of the 50-cent tax, 1868–'69, and to $55,606,000 in the succeeding year, 1869–'70; a gain to the Government in two years of over sixty millions of dollars in revenue, with great diminution of fraud and great relief to the industries of the country.

Up to the year 1867, Mr. Wells, who was born and reared a member of one of the largest manufacturing and Whig families of New England, was an extreme advocate and believer in the economic theory of protection. In 1867, Congress having instructed the Secretary of the Treasury to present at its next session a draft of a new tariff looking to reductions of war-rates, and the business of preparing the same having been turned over to the office of the Special Commissioner, Mr. Wells, with a view of qualifying himself for the work, visited Europe under a Government commission, and investigated, under almost unprecedented advantages, nearly every form of industry, competitive with the United States, in Great Britain and on the Continent. The results of this visit and investigation enlightened him in respect to two salient and fundamental points: *First*, that no country, with the exception of the United States, which had adopted in a greater or less degree the policy of protection through duties or restrictions on imports, had ever regarded the taxation of the importation of crude, or partially manufactured articles to be subsequently used for larger manufacturing, as a feature of protection to its domestic industry, but rather as antagonistic to and destructive of such industry; and that while such taxation in the United States had undoubtedly built up some industries and enriched their owners, it had been a great restraint on the development of a much larger and higher class of industries, employing many more workmen and paying much higher average wages; a taxation imposed then and now, for example, of from thirty to forty millions per annum on the importation of crude and partially manufactured articles, being a tax of ten per cent on a product of three or four hundred millions of finished products, thereby excluding them from all sales in the markets of the world, in competition with similar products not subject to such price enhancement. And, *second*, that the countries of Europe—like Russia and Austria—in which the average rates of wages are lowest, were the most clamorous for protective duties on foreign imports; and that high wages in any country, conjoined with the extensive and skillful use of machinery, instead of being evidences of industrial weakness, were evidences of great industrial strength; inasmuch as no employer can continuously pay high wages unless his product is large, his labor most effective, and his cost of product, measured in terms of labor, low. These personal experiences in respect to European industry, coupled with a subsequent study of our customs system, and a complete redrafting of our whole tariff rates under instructions from Congress through the Secretary of the Treasury, gradually, and greatly against all his preconceived ideas, led Mr. Wells to a complete abandonment of his original position as a strong protectionist, and to the adoption of the belief that free trade, made subordinate to revenue and progressively but tentatively entered upon, was for the best interest of the whole country.

The announcement of these views, and especially the publication of his report for 1869, created great opposition among the protectionists, and Horace Greeley publicly charged that Mr. Wells had been corrupted through British gold distributed through the agency of Mr. A. T. Stewart. Mr. Stewart, exceedingly angry at being brought into this matter, desired that Mr. Wells should at once institute proceedings for libel, and several leading members of the New York bar volunteered to take charge of the case. But Mr. Wells felt that it was not necessary to vindicate his public or private character by any such action, and refused to become a party to it. The story, nevertheless, found extensive credence, and is undoubtedly believed by many persons at the present time who are unable otherwise to account for such a change in the economic opinions of the Commissioner so shortly after his return from Europe.

A draft for a very complete revision of the tariff, prepared by Mr. Wells in accordance with instructions, together with a full and elaborate report on the existing revenue resources and condition of the country, submitted to Congress through Secretary McCulloch, and with his hearty indorsement, in December, 1867, nevertheless found great favor, and, embodied in a bill, with slight modifications, came very near being successful. The Senate passed it by a vote of 27 to 10. In the House it failed, in the closing hours of the session, by a very few votes—and not by a direct vote, but on a motion to suspend the rules, take the bill from out the Committee of the Whole, and "put it on its passage." This motion, which required a two-thirds vote, was defeated—106 in the affirmative to 64 in the negative. It was thus made evident that, could the bill as it came from the Senate have been brought directly before the House, it would have passed by a large majority, and probably have quieted for years all tariff agitation.

When the office of Special Commissioner expired by limitation in 1870, President Grant, giving the personal dislike of the Secretary of the Treasury at that time—Mr. Boutwell—to the Commissioner as a reason, refused to reappoint Mr. Wells in case of a renewal of his office. On his retirement in July, 1870, a large number of members of both Houses of Congress, without distinction of party, united in a letter headed by Messrs. Sumner, Trumbull, Carpenter, Henry Wilson, Buckingham, Anthony, Thurman, Schurz, Bayard, Edmunds, Fenton, and others, on the part of the Senate, and Messrs. Blaine, Garfield, Logan, Allison, Cox, Hooper, B. F. Butler, Kerr, Dawes, Eugene Hale, Banks, Poland, Oakes Ames, Niblack, Randall, Brooks, Beck, J. A. Griswold, James Brooks, A. A. Sargent, J. F. Wilson, F. Wood, Noah Davis, D. W. Voorhees, W. H. Barnum, and others, on the part of the House—of which the following is an extract: "The undersigned, members of the Forty-first Congress, who have been cognizant of your labors as Special Commissioner of the Revenue, take the occasion of your retirement from public duties to express to you their appreciation of the work you have accomplished, and the great ability with which you have discharged the duties of your office. How much soever they may perhaps have differed with you touching the matter of your conclusions upon particular points, they desire nevertheless to bear testimony to the great value of your work, and to the honesty and the faithful and untiring zeal which have characterized your whole public career." At the same time a committee of citizens of different States, members of both parties, presented to Mr. Wells several testimonials of great value; one of which, a superb bronze statuette, some thirty inches high, representing "Labor," in the form of a fully-developed workman, leaning upon his sledge-hammer, bears upon a silver plate the following inscription:

PRESENTED TO
HON. DAVID A. WELLS,
ON HIS RETIREMENT FROM THE OFFICE OF
SPECIAL COMMISSIONER OF THE REVENUE,
BY CITIZENS OF NEW YORK AND NEW ENGLAND,
AS A TOKEN OF ESTEEM FOR HIS UNSULLIED INTEGRITY
AND HIGH PERSONAL CHARACTER; AND AS A SLIGHT
RECOGNITION OF HIS INESTIMABLE SERVICE TO HIS COUNTRYMEN.

Commenting on the discontinuance of the office of Special Commissioner of Revenue, the "North American Review" used at the time the following language: "The system of taxation, by which the Government has been in receipt of its enormous income, was established during the war; and the man who deserves the most credit for its reform is Mr. David A. Wells, whom General Grant and Secretary Boutwell united in bowing coldly out of the public service. It was he who proved the capacity of the country to stand an enormous taxation, and pointed out the most convenient and legitimate sources of revenue; and the most continuous changes and improvements in our revenue system, including even those under the Administration that dismissed him, were but the following out of the suggestions and the line of argument which he had presented while in the Treasury Department. To him and to Congress, and to a generous and patriotic people, does the country owe the proud exhibition of debt and tax reduction."

General Garfield, in a debate in the House of Representatives, July 13, 1868, also paid the following handsome tribute to the work of Mr. Wells as Revenue Commissioner, saying: "I do not believe that any man appointed by the Government in the civil service has done for this country more work, and more valuable work, than David A. Wells. Into the financial chaos resulting from the war he threw the whole weight of a strong, clear mind, guided by an honest heart, and during the last three years he has done more, in my judgment, to bring order out of chaos than any one man in the United States."

As soon as it was known that Mr. Wells was to retire from his office at Washington, the appointment as chairman of a State commission for investigating the subject and the laws relating to local taxation was tendered him by the Governor (Hon. John T. Hoffman) of the State of New York and accepted; and in this new position Mr. Wells prepared and submitted to the Legislature two reports (in 1872 and 1873) and a draft of a code of laws. Both of these reports were subsequently reprinted in the United States and in Europe; and one of the first acts of the French Minister of Finance (M. Wolowski), after the conclusion of the Franco-German War, was to order the translation and official publication of Mr. Wells's report as Special Commissioner of Revenue for 1869. This compliment was further supplemented in the spring of 1874 by the election of Mr. Wells, by the French Academy, to fill the chair made vacant by the death of John Stuart Mill, and also in the same year by the voting to him of the degree of D. C. L. by the University of Oxford, England. The honorary degree of LL. D. had been previously given to him by the college of his graduation (Williams), and that of M. D. by the Berkshire Medical College in 1863. In 1873, on invitation of the Cobden Club, Mr. Wells visited England and delivered the address at the annual meeting and dinner of the club. In 1872 he was invited to lecture on economic subjects at Yale College. In 1875 he was elected President of the Democratic State Convention of Connecticut; and he has served twice as delegate at large from Connecticut to Presidential nominating conventions, i. e., in 1872 and 1880. In 1876, Mr. Wells, after refusing to accept a regular nomination for Congress in the third district of Connecticut, was put upon the course by resolution of the Democratic convention, with the result, in the face of conditions otherwise wholly favorable to the Republicans, of reducing a hitherto impregnable Republican majority from 1,176 to 40.

In 1870 Mr. Wells was elected a member of the Cobden Club; in 1871, honorary member of the Royal Statistical Society of England; in 1875, President of the American Social Science Association, succeeding Dr. Woolsey, of New Haven; in 1877, a foreign associate member of the Regia Academie dei Lincei, of Italy; in 1880, President of the New London County (Conn.) Historical Society; and in 1881, President of the American Free-Trade League. In 1878, Mr. Wells was appointed by the President a member and subsequently elected President of the National Board of Visitors to the United States Military Academy at West Point. In 1876 he was appointed by the United States court one of three trustees and receivers of the Alabama and Chattanooga Railroad, and in the course of the following fourteen months rescued the corporation from bankruptcy, and expended a considerable sum for improvements and repairs, without incurring an additional dollar of indebtedness. In 1877 he was appointed by the State Board of Canal Commissioners chairman of a commission to consider the subject of tolls on the New York canals, and in the next year made an exhaustive and acceptable report.

In 1879, in connection with the late E. D. Morgan, of New York, and J. Lowber Welsh, of Philadelphia, and as trustees of the bondholders, he bought under foreclosure and sale, and reorganized the New York and Erie Railroad, and served for some time as a member of the finance committee of the board of direction of the new company. In 1879 he was elected by the associated railways of the United States, in connection with Charles Francis Adams, of Massachusetts, and John M. Wright, of Philadelphia, a member of a board of arbitration, to which the associated railroads agreed to refer all their disputes and all arrangements for pooling or apportioning their respective competitive earnings. For two years the efforts of this board were successful and acceptable; but, at the commencement of the third year, from causes to which the board was not a party, arbitration was refused by certain roads, and the arrangement was first suspended, and finally terminated. Pending final action as to the continuance of the board, Messrs. Wells and Adams voluntarily relinquished the sum of ten thousand dollars each, that was due them, on the ground that no service having been required of them or given, they were not honorably entitled to compensation for doing nothing.

During the last twenty years few Americans have written and spoken more frequently and more acceptably to the public on subjects connected with the industry, commerce, finance, shipping, railroads, taxation, and labor of the country, than Mr. Wells; and some of his productions in pamphlet form, as "The Primer of Free Trade," "Why we Trade and How we Trade," and "The Dollar of the Fathers *vs.* The Dollar of the Sons," have attained a wide circulation. Of books, the following are well known: "Robinson Crusoe's Money," illustrated by Nast, or the experiences of an island people in using different kinds of money, 1876; "Our Merchant Marine; How it Rose, Increased, Became Great, Declined, and Decayed," 1882; "Practical Economics," 1885; "A Study of Mexico," 1887. Concerning the latter work, M. Romero, the Minister of Mexico to the United States, writes: "Although I differ with you on several points, and in respect to some of your conclusions, it is surprising to me how well you have understood the condition of Mexico and its difficult problems, especially so far as its relations with the United States are concerned." To which the Rev. George B. Hyde, one of the leading and oldest missionaries of the Methodist Episcopal Church in Mexico, adds, under date, at the Mission of Puebla, of May, 1887: "I have, I think, read all works of importance relating to the social and political economy of Mexico; and the 'Study' is the only one that has not either looked with eyes that saw a paradise or a desert. I consider the book the most valuable yet published on the real condition of Mexico."

The series of papers "On the Economic Disturbances since 1873," now publishing in the "Popular Science Monthly," being also reprinted concurrently in Europe, are regarded both in this country and Europe as among the most instructive and valuable contributions that have been made in recent years to any department of economic science.

Mr. Wells's present residence is at Norwich, Connecticut, where he is the owner of one of the most pleasant old-fashioned houses in New England, and one of the best private economic libraries in the country.

CORRESPONDENCE.

INDIVIDUALITY IN OUR SCHOOLS.

Editor Popular Science Monthly:

BY the common consent of mankind, individuality is considered one of man's highest characteristics. During the early history of the republic, it was a much more common possession of our people than at the present time. In looking for the causes that have produced this loss of a prominent trait, the mind involuntarily stops to dwell upon our system of grading in the common schools of the country. By this system there is established a level to which it is believed all can attain. I am willing to concede that it tends to stimulate the dull scholars to rise to a higher level than they would naturally reach; but unfortunately it also prevents the bright ones from going forward to higher standards. It is said that the greatest good to the greatest number is the desired object, but this is a false statement of the facts, for it is to the bright scholars that we must look to finally carry all to higher attainments. This system of grading at once prevents the working out of the law of evolution; and we may truly assert that some, at least, of the graduates of our schools have reverted to common types, instead of developing to ever-higher standards. We can not stand still: if the scholars in our common schools do not go forward, then there is reversion. The world goes on and leaves them.

Perhaps the most glaring fault of the system is, that it turns out graduates with minds all cast in the same mold. Many of them are bright and capable young men and women, but they have been so educated that the girl graduates all want to be teachers, or marry rich men for a career in life, with now and then one who enters the pulpit or the medical profession; while the male graduates seldom see any other career open to them than law or medicine, with now and then one that enters the pulpit. At the same time the services of these young men are in demand as surveyors or engineers upon our railroads, and in the new avenues of employment created by the many wonderful recent inventions, especially in handicraft and industrial pursuits. It is just here that our schools are deplorably deficient. They ought to educate the hand as well as the head of the pupils, for industrial employments must, in the end, be the life-work of the majority of them. There is one lesson of the late civil war that I think has not been properly studied. The Southern States have never made use of graded schools, or had not done so before the war of the rebellion. That there was far more individuality in the South than at the North the history of the war abundantly shows. The Southern people had a surplus of able commanders for their armies, while we of the North, with resources and numbers far superior to theirs, saw our armies turning from one point of the compass to another, making no progress, because our commanding generals were routine men, most of them graduates of our common schools, without the ability and genius for command, or foresight to plan a great and comprehensive campaign. We made little or no progress until President Lincoln, a grand, self-educated Western man, saw the reasons of our constant defeat, and changed his commanders from Eastern common-school graduates to Western men, who had been trained in the non-graded, log-housed schools of the West, where the individuality of the pupils had not been repressed by this dwarfing process.

We sometimes hear a phrase in New York and in the New England States, "The Ohio idea," and there are often an inflection and a tone of the voice indicating contempt in connection with it. The tone and inflection are nothing but the same sneer that was observed during the civil war upon the countenances of these Eastern common-school graduates when Mr. Lincoln turned them out, and put Grant, Sherman, and Sheridan in their places. The meaning of "the Ohio idea" then was individual development in contrast with the system of repression in the common schools of the East; for in Ohio, previous to the war, there had been but little of that grading process now conforming the schools of the West to Eastern standards. Would it not be well for our educators to study this topic, and try to find out a system that develops the individual as an individual, and not as one of a class or grade? Individuality can not be repressed without final disastrous results. The system of common schools of a State that developed Grant, Sherman, Sheridan, McPherson, and Garfield was not paralleled by any State in the East, where graded schools have existed the longest. In short, the point that I desire to present is that it is a violation of individual and natural rights for the State to make one individual smaller that another may be larger. General Grant was worth more to the nation than an army of common men.

D. S. MARVIN.

WATERTOWN, NEW YORK, *February* 25, 1888.

THE "LONG AND SHORT HAUL."

Editor Popular Science Monthly:

IN the correspondence department of your March number is a note from Mr. Thomas L. Greene, in which he questions the accuracy of some statements contained in my article in the February "Monthly." I admit that the ill effects of the long and short haul section are not apparent in cases where its enforcement is suspended. My criticism was written some six months since, and before the policy of the commission of granting "temporary relief" had become so well defined as has since been the case. At that time the assumption seemed warranted that that law (like all other laws) was to be generally enforced. The exercise of "temporary relief" (permission to violate), which it is optional with the commission to apply or withhold in specific cases, places a tremendous power in its hands, and only the fact that its present members are incorruptible insures present safety. All *law*, theoretically, is general, impartial, and just in principle, but when its enforcement or violation is left optional with any tribunal, however competent, there is danger ahead. It would be unique to include among the *merits* of a law the easy facilities for its violation.

HENRY WOOD.

BOSTON, *March* 2, 1888.

"THE TIME OF FIGS."

Editor Popular Science Monthly:

IN my letter, which you published in the March number, my main object was to state the fact that the fig-tree in southern Palestine should have figs in some stages of development on it at all seasons, though it is a fact that, in some varieties of figs, the fruit is a long time in ripening. The fruit of three seasons is sometimes found on the tree at the same time. It is true that one of the evangelists states that "the time of figs was not yet." That remark can only mean—as nearly all commentators interpret it—that the time of general harvest of figs for preserving purposes had not yet arrived; consequently, it was an additional reason for the condemnation of the fruitless tree, instead of a reason why it should not be condemned.

J. W. HUNTOON, M. D.

LOWELL, MASS., *March* 1, 1888.

EDITOR'S TABLE.

SCIENTIFIC HABITS OF THOUGHT.

IT is a question well worth considering, how scientific habits of thought are best to be formed, maintained, and strengthened. Such is the prestige of science in the present day, so thoroughly is scientific reasoning recognized as the type of all true reasoning, that nobody with any pretensions to intelligence would wish to be accused of thinking unscientifically. At the same time there is a vast amount of unscientific thinking being done on every hand; and men of almost every grade of culture may be found, the tone of whose minds is unscientific to the last degree. Let us see if we can throw into some kind of acceptable shape the general principles to be observed by whosoever would be saved from irrationality and a spirit of opposition to the truth—whosoever would wish to have scientific habits of thought in the best sense.

It is probably correct to say that science was first forced upon men's minds by the repeated presentation of the same phenomenon with an unvarying accompaniment of antecedent and consequent. Without entering upon a discussion of the nature of our conception of cause, we may say that science is nothing else than a knowledge of the permanent relations, whether causal or other, of things to one another. Nature, in the first place, forces us to recognize certain uniformities: some minds not only learn the particular lesson so taught, but, entering into the spirit of Nature's teaching, run on to discover further uniformities for themselves. These, to whatever age they belong, are the scientific spirits of their time. Others there are who look upon every such lesson as an infringement of their natural liberty to think and believe without any reference to the bounds of law. These learn only what they must, and, beyond the region of palpable and irresistible demonstration, love to indulge the most wayward and fantastic beliefs. In these we see the enemies of science, unwilling learners in Nature's school, rebellious spirits who fain would fashion the universe to their own liking. The first condition, therefore, of scientific thinking is to recognize and to bow to Nature as the supreme teacher, and to feel that she has an inexhaustible fund of wisdom to impart. He who thinks scientifically recognizes no authority save that of demonstration. He gladly avails himself of the help of superior minds, but he does not swear by their words; for, great as they may be, and as he may acknowledge them to be, he can not regard them as infallible. Partisanship in science is almost a contradiction in terms. The expression "schools of thought" even is one to be accepted with caution; seeing that no one should wittingly attach himself to any school save the great school that Nature keeps ever open to all. Too much emphasis, indeed, can hardly be laid upon this view of the matter. The pursuit of truth partakes of the character of a religion; and the mind that is imbued with the religion of science never for a moment places any human authority, however great, in the place of the truth which, by no violent figure of speech, he may be said to adore. Truth has its ministers, but it has no priests, no class of men whose mere office summons to reverence. We ask respecting the ministers of truth simply how much of its illumination they have received, how much they are able to impart; and we honor them in proportion to the clearness and strength of their thought and the fruitfulness of their labors.

The more we dwell upon and develop the thought of Nature as the teacher, the more we see that the whole of scientific thinking depends upon loyalty to this one source of light. Every unscientific attitude of mind or movement of thought we ever heard of has had, for its main characteristic, an ignoring of Nature and a following after idols whose power was supposed to be superior to Nature. In all ages men have more or less resented the blessed bonds that have made them captive to earth and to its laws. Because their thought could traverse the heavens, and because their imagination could conjoin the most opposite elements and conditions, they have sighed after equal liberty for their active powers, and have run eagerly after whatever promised to emancipate them from the ordinary conditions of life. Hence the fanaticisms that have possessed and oppressed mankind; hence most of the delusions to which they have fallen subject; hence the scorn that, under certain systems of thought, has been, and is still, cast upon this present life; hence the prevailing indifference to, and depreciation of, what claims no higher sanction than natural or human law.

In the study of Nature there is one caution to be observed, and that is that absolute truth is not to be expected. Nature is willing to teach us, but she treats us like the children we are, using the symbols best suited to the range of our comprehension, but not laying bare her ultimate secrets. A large part of the scientific temper consists in recognizing this. He who imagines that, because he has made a generalization under which a certain group of facts can be advantageously presented and explained, he has struck the rock-bed of eternal truth, is a scholar rather pert than solid, and Nature will probably rebuke him some day. Newton knew well that in his great generalization he had merely succeeded in measuring a force the real nature of which it was wholly beyond him to explain; and the greatest scientific intellects of the present day are precisely those that most fully acknowledge, because they most deeply feel, the merely provisional character of the most important scientific hypotheses.

A third note of the scientific mind is practicality of view. The highest reverence for truth is not inconsistent with a desire to put truth to practical uses. Nature is the supreme teacher, and yet, from a certain point of view, Nature may be said to exist for us, not we for Nature. We lay hold of her phenomena with a masterful grasp, and read laws into them, reserving to ourselves the right to read ever wider and higher laws as our knowledge widens. And when our minds are in free and unrestrained movement, and are being built up in symmetry and strength by what they absorb in the study of external things, we feel that the highest work of which we can form any conception is being accomplished. There are scientific workers whose whole ambition seems to be to form a kind of *hortus siccus* of observations and opinions, and whose own minds are but little transformed by the knowledge that passes through them. These lack the true scientific spirit, though their work may at times have its uses. They lack the joy of growth, and never realize the sense, at once of liberty and power, which those possess who look upon nature, not as a mere curiosity-shop or museum, but as a vast domain providing all that is necessary for the exercise, aliment, and discipline of the human mind.

The truly scientific spirit, we may lastly say, is essentially inductive. It feels its way into truth by slow degrees. If facts are at all accessible, it does not care to depend on hypotheses; and it is always ready to accept the yoke of facts—never tries to put a yoke on facts. In this respect it differs greatly from the disposition shown by many radical thinkers of to-day, who, having thrown overboard their former theological opinions, are none the less governed in their daily thinkings by old theological methods. Such confidence have these persons in their argumentative that they never seem to care to freshen their thought with new knowledge. Such and such are the cardinal principles in which they believe, and from these they are prepared to draw an ever-lengthening chain of conclusions, all, as they hold, of absolute certainty because the starting-point was, in their opinion, indubitably true. No man, however, who has a glimmering of the scientific spirit cares to follow this kind of dead-reckoning. "He to whom the Eternal Word has spoken," says a famous mediæval sage, "is set free from many opinions." So he, we may say, to whom Nature has spoken in intimate tones, who knows what it is to have studied Nature patiently and faithfully, is freed from all bondage to mere opinions by his supreme attachment to truth. His great interest lies in knowing what is, not what, according to somebody's way of looking at things, ought to be.

We may know the man, therefore, whose habits of thought are scientific by his abiding faith in the teachings of Nature; by his unshaken conviction that the uniformities we see in the occurrence of phenomena are but hints of the universal constancy of natural law; by his interest in all that can be brought under law, and lack of interest in all alleged lawless and abnormal manifestations; by his recognition of the inaccessibility of absolute truth, and his willingness to make the best of provisional theories and symbols; by his freedom from pedantry and dilettanteism; by his reverence for human nature; by his constant desire for the verification of opinions, and his consequent freedom from all infatuation, whether for the theories of others or for his own. He is a man whose moderation is known to all men, whose patience seems to have been learned from Nature herself, whose thought moves from year to year in larger circles, and whose character bears witness to the liberal and elevated character of his daily occupations. Do all men of science, all professors of philosophy, conform fully to this type? No, but this is the type to which, in so far as they are true to the spirit of philosophy and science, they will all, gradually, more and more conform.

DEATH OF PROFESSOR GRAY.

The death of Asa Gray removed a student who was looked up to in all the world of knowledge. In many aspects he had no master, and there were few who could be regarded as his peers. In his special field his leadership was recognized—in all nations. The help and sympathetic co-operation he gave to Darwin in building up the doctrine of variation and natural selection show him to have been a pioneer in the advance of science as a whole. His success in presenting the details of what was considered one of the driest of scientific subjects in such a way as to make his treatises as readable as a book of travels entitles him to a high position in literature. The company of American botanists who, having drunk their inspiration from his books, are carrying on their work in a like spirit, are a testimony to his powers as a teacher. And the Church, when it has purged itself from the heresy that every discovery in science overthrowing some old notion is an attack on religion, will be able to point to him as a man consistent and diligent in both spheres of life, to whom it never occurred that there was any conflict to be adjusted.

The history of learning is full of examples of men who have risen to eminence from the most incongruous surroundings, without adventitious aids, but solely by the force of their own impulses. Professor Gray affords another. His advantages were of the most limited character. His working life began with tending his father's tan-bark mill, while he was distinguished as being the champion speller of his school district. Two years at a grammar-school, one year at the academy, and a medical course, constituted his entire formal education. He had no classical training, no scientific instruction further than was subsidiary to the medical studies of which he made no use. But he became one of the leading scientific men of his age, and, as Professor Dana remarks, "eminent for his graceful and vigorous English, the breadth of his knowledge, his classical taste, and the acuteness of his logical perceptions." An article in the "Edinburgh Encyclopædia" directed his attention to botany. He procured Professor Eaton's text-book, which was perhaps one of the best on the old system—but how different from the works of the series with which he made the science luminous!—and began his brilliant scientific career with the analysis of *Claytonia Caroliniana*. He must have been proficient in his studies, for we find him before the close of his medical course taking the place of the professors in lectures at Albany and Hamilton College. Then he became a regular teacher himself; was associated with Dr. Torrey in his researches; published his own investigations of the sedges and of the plants of northern and western New York; and prepared his first text-book, "The Elements," in 1836, a book in which, according to Professor Dana, the subjects of vegetable structure, physiology, and classification were presented in a masterly manner, and which "showed his customary independence of judgment and clear head in various criticisms and suggestions."

The name of Professor Gray is intimately associated with Darwin's in the history of the theory of the origin of species. The series of letters from Darwin to Gray, contained in the recently published "Life and Letters" of Darwin and beginning on page 420 of the first volume, attest the respect Darwin had for his knowledge, the confidence which he reposed in his opinions, and the hearty fellowship that existed between them. Gray, Lyell, and Hooker were the three whose approval of his theory Darwin most desired to enjoy, and were the three to whom he earliest and most fully confided his views. Yet Gray and he did not agree entirely in their acceptance of the theory. While Darwin gave the predominant place to the environment in determining variation, Gray thought that the process worked more from within and was at most modified or limited by the external conditions. Darwin had extreme difficulty in accepting the conception of a Supreme Intelligence ordaining and controlling the process of evolution; Gray held to a complete harmony between the working of a Supreme Power and of evolution, and declared that "natural law is the human conception of continued and orderly divine action."

Professor Gray's "Statistics of the Flora of the United States" and his observations on the plants of Japan have an important bearing upon the theory of the origin of animal and vegetable life in the polar regions and their distribution thence down the continents, which is now advocated by biologists and paleontologists of high standing.

Professor Gray has not been conspicuous as a man of letters, but we may justly claim for his botanical works a place in literature as such. He contributed to the "American Journal of Science" biographical notices of deceased botanists and reviews of botanical work in which his accurate criticisms were tempered by a uniform kindliness of spirit, and he made considerable contributions to the "North American Review," "The Nation," and the "Atlantic Monthly." A volume of selections from these contributions, with a chapter on "Evolutionary Teleology," was published in 1876, under the title of "Darwiniana."

Professor Gray's personal character was admirably characterized by Darwin, who concluded, before he had even seen him, from reading some of his letters to Hooker, that he must be a man with something very lovable about him. A friend, paying a tribute to him in the London "Spectator," speaks warmly of his "singularly sweet and beautiful nature," and of "the freshness and brightness that recalled nothing but youth," of which not years nor learning, nor incessant studies, nor even the classification of the American *Compositæ*, could deprive him; and added that Darwin's son, to whom he sent a parcel of stamps to cheer his sick-bed, "was not the only English child who received a like present from the same giver."

What the world of science thought of Asa Gray is attested by the honors which its schools and its societies conferred upon him, and by the respect, as to one having authority, in which he is invariably spoken of by its most distinguished writers. American feeling was reflected in the token which was presented to him a little more than two years ago by one hundred and eighty-five botanists, all in a sense his students, with Mr. Lowell's quatrain.

Professor Gray was taken away from the midst of his work. He had just completed a review of Darwin's "Life and Letters," had not quite finished the revision of his "Vitaceæ," and was busy with his "Necrology" for the "Journal of Science," when he was stricken.

HOW IT WORKS.

One of the recognized evils attendant on the public-school system of this country is the insecurity of the tenure by which teachers hold their situations. So manifest an evil has this been that in certain States it has been proposed to remedy it by legislation. But, supposing the evil entirely removed, what would the result be? We can perhaps judge by what one of the best conducted of our educational journals says is the case in the great State of Illinois. We are not aware at this moment what is the law in that State respecting the appointment of teachers, but from what our contemporary, the "Illinois School Journal," says, some teachers, and other school officials as well, have only too strong a hold on the positions they fill. "One of these," —we quote from the "Journal"—said the other day: "Why should I read books or bother my head to study about teaching? What will it profit *me?* My place is secure. I have as many friends as my principal or superintendent has. Let him try to remove me if he dare." "There is much of this spirit," continues the "Journal," "in the schools, especially in the large cities. It is not among the teachers alone. It is among principals and superintendents as well. These people long since ceased to study and grow." So, here is the dilemma: If the teacher has no security of tenure, he has no encouragement to throw himself heartily and earnestly into his work. If, on the other hand, he has, either through legal enactments or through his political associations, a firm hold upon his place, he is in danger of lapsing into the condition of mind and general disposition above described. It may be said that security of tenure, in the sense understood by the teachers, would not mean exemption from proper official supervision and authority, or an absolute right to employment in spite of proved disqualification; but, admitting this, it is still clear that, under such a system, the difficulty in the way of getting rid of indifferent or even of seriously deficient teachers would be very great. The "Illinois School Journal" says distinctly, and, as we think, truly, that we shall only be able to improve the schools when we have learned how to improve the teachers. What kind of material is offered, under the present system, for the teaching body we learn from a further article in the same periodical by a gentleman who states that he has been for years a member of the State Board of Examiners. "Experience," says this authority, "shows that many candidates fail on common English branches, particularly arithmetic and reading. . . . The papers show such deficiency in form as to indicate that teachers are extremely careless in this respect. The arrangement of work, the carelessness in regard to paragraphing, and even the use of capital letters, shows gross neglect of the proper usages of written language. Some show that they learned their spelling late in life, and that, when hurried, they revert to some juvenile form. . . . The worst and least excusable mistakes were in the definition of common words. Defining a noun by a verb, a verb by an adjective, an adjective by an adverb, was altogether too common. The derivation of words was hopelessly, painfully ridiculous." The examination papers in connection with which all this occurred are appended to the article from which we quote; and their extreme simplicity makes the statements of the article only the more surprising. The history, geography, arithmetic, and etymology are well within the compass of any fairly-taught lad of twelve or thirteen. Samples of the answers given are also furnished; and all we can say is that they well deserve a place beside Mark Twain's famous collection. One candidate who, in the paper on pedagogics, was asked to "define the terms *subjective* and *objective* as used in mental philosophy," answered that "we treat a topic subjectively when we take what we know of a subject and explain, without having any special object in view." Evidently, all that this individual knew of his "topic" would not have afforded a basis for much explanation, with or without an object in view. A very noticeable feature is the thorough dishonesty of many of the answers. Being asked to give the etymology of the word "urbane," one candidate said it was from *ur*, outside, and *bane*, city; another that it was from *ur*, a city, and *bane*, badly. Each of these would-be teachers and guides of the young knew that he, or she, was "guessing" in the most shameless manner—that is to say, practicing one of the very vices to which school-children are most prone, and which it is the duty of their teachers most earnestly to reprehend and repress.

Of course, it will be said that the worst cases of ignorance and incompetency were culled out by the examination; but the language of the article referred to indicates clearly enough that the general average of the candidates was low; and, if so, it may be assumed that many very poorly qualified persons crept through and got their certificates. And this is how the system is working to-day, when so many improvements on the old order of things are supposed to have been made. We greatly fear that, between the politics that make good teachers insecure, and bad ones secure, in their positions, and examinations that are largely farcical in their character, the interests of the rising generation are not being very intelligently or conscientiously studied. Good men and women no doubt there are, and many of them, engaged in the State schools; but these, we fear, can not avail to save the whole system from gravitating to that low point of efficiency which marks governmental action in all matters which lie outside the necessary and natural functions of government.

LITERARY NOTICES.

Animal Magnetism. By Alfred Binet and Charles Féré. "International Scientific Series," Vol. LIX. New York: D. Appleton & Co. Pp. 378. Price, $1.50.

Mesmerism, hypnotism, or animal magnetism, has had varied fortunes. Forced into the field of scientific discussion about a century ago by the elaborate pretensions of Mesmer, it has been alternately cultivated, condemned, and neglected by scientific men, and has been fostered chiefly by quacks as a ready means of exciting the admiration and opening the purses of the curious. At present the subject is one of growing interest. It is receiving respectful attention generally in the scientific world, and is being studied in a conservative manner by certain specialists. The exceptional advantages for the study of nervous phenomena afforded by the medical practice in the Salpêtrière, the great hospital for women in Paris, have been employed with important results. The observations and experiments recorded in the present volume have been made in that hospital, and in accordance with the method inaugurated by M. Charcot, the chief of the school of the Salpêtrière. The book aims only to give an account of these researches, and, notwithstanding their number and variety, the authors do not feel that enough material has yet been collected to base general conclusions on. In the first three chapters a history of the subject is given, after which the investigations of Charcot and his pupils are taken up. These observers recognize three chief states of hypnotism: catalepsy, lethargy, and artificial somnambulism, the modes of producing which, together with their symptoms, are described. Then follows a study of suggestion, or the power of an experimenter to make a hypnotized subject speak, act, think, and feel as it pleases the former to dictate. Hallucinations affecting each of the senses may be impressed upon the subject, and even unilateral hallucinations may be produced. Suggestions of acts to be performed at once or at some future time may be given, and, though the acts may be repugnant to the subject, he can not refrain from performing them. Insensibility to touch, and even to the pain of a surgical operation, may be produced by suggestion, and motor paralysis as well. All these phases of the subject are illustrated by a great variety of cases. Attention is called in the two closing chapters to certain applications of hypnotism. First, hypnotism may become a valuable curative agent for real diseases caused by the imagination, which appear in persons having a certain weakness of the nervous system. This fact throws light on the subject of miraculous cures and mental healing, which has recently attracted so much attention. Second, it may be employed for certain cases in education. Finally, the accomplishing of criminal acts upon or by means of a hypnotized person, and the obtaining of true or false testimony by means of hypnotism, constitute a branch of the subject which society may soon have to take serious account of. Although dealing with phenomena that border on the marvelous, this book is not at all sensational, and the reader may rest assured that it will give him a sound scientific view of the interesting field which it covers.

An Inquiry into Socialism. By Thomas Kirkup. London and New York: Longmans, Green & Co. Pp. 188. Price, $1.50.

An intelligent exposition of the principles and aims of socialism from one of its supporters is certainly welcome at the present time, when public attention is directed so universally toward important socialistic movements. This volume presents the author's views as to the evils of the existing industrial system, his interpretation of the essential ideas of socialism, and a review of the prospects of the latter. It is a very readable work, is well written, and gives in small compass a great deal of useful information and valuable discussion upon all the topics above mentioned. It is of similar character to Professor Graham's "Social Problems," though going beyond the latter in its belief in the efficacy of socialism as a system to remedy the ills afflicting society.

We think the account of the evils of the present industrial system is the best part of the book. We are quite unable to agree with the author in his evidently sincere conviction that socialism will furnish any permanent remedy for those ills, and do not think he demonstrates how it can. This, however, is a matter of difference in fundamental principles. But the main criticism we pass upon the work before us is that it stretches the term socialism so far as to embrace almost everything that makes for the improvement of human life and conditions. Socialism is justice, altruism, practical Christianity, progress, social evolution; and these in turn are socialism. We are unable to allow the propriety of thus connecting the latter term with all these beneficent things. As most people suppose, socialism is in principle the accomplishment by state action of co-operative production and the equalization of distribution, using the state for positive amelioration, instead of confining its offices to guaranteeing liberty and security. We should not let our enthusiasm for any *ism* run away with our powers of observation; and certainly these, if properly exercised, would show us that it is highly premature at any rate to cover by the common designations *socialism* and *socialistic* all the ideals of a better social order, and all the most promising methods for attaining it. But this is really what the author seems to do; he makes a cult, and worships blindly an idealized deity, without taking sufficient pains to find out the real character of his idol.

The Ventilation and Warming of School-Buildings. By Gilbert B. Morrison. "International Education Series," Vol. IV. New York: D. Appleton & Co. Pp. 173. Price, 75 cents.

The author of this treatise presents both the theoretical and the practical sides of his subject, and the principles which he sets forth are applicable to all other buildings as well as to school-houses. He describes first the necessity for ventilation, and the methods of detecting impurities in air, and then discusses various modes of natural and artificial ventilation. His chapter on ventilation by windows will prove useful in many cases where no better means for the purpose exist. Another chapter gives careful estimates of the cost of ventilating. The subject of warming is treated in a similar manner, and the final chapter of the volume is devoted to the ideal plan for warming and ventilating combined, which has grown out of the author's study of these allied subjects. An appendix contains various thermal formulas and notes in regard to certain mechanical ventilating appliances. The volume is illustrated.

The Annual Report of the Chief Signal-Officer for 1886. Washington: War Department. Pp. 500.

This volume contains the usual statistics in regard to military signaling and the Government Weather Bureau. The proportion of weather indications verified during the year was 78·48 per cent.

Dress. A Monthly Magazine, conducted by Mrs. Annie Jenness Miller. New York: The Gallison & Hobron Company. Price, $1.50 a year.

This periodical, whose first number appeared in May, 1887, is devoted primarily to "the practical and the beautiful in women's and children's clothing," but gives attention also to physical culture and kindred subjects, while fiction and poetry are not excluded from its pages. "The Popular Science Monthly" has at various times called attention to the unhealthful features of the current mode of women's dress, and indicated the principles of a correct system; hence we heartily indorse the effort of "Dress" to secure the general adoption of a style of clothing for women which does not cause torture and disease of the body and distraction of the mind. In order to find acceptance, such an improved system must fully equal in beauty and neatness the fashionable costumes of the day. Mrs. Miller is giving due attention to this condition; her designs for suits and toilets seem attractive enough to insure for her system the success which its hygienic character deserves. The under-garments which she advocates are of the union pattern, and consist of a jersey-fitting garment next the skin, over which is worn a "chemilette," and over this "leglettes," either plain or full, which take the place of petticoats. Outside of these comes the gown-form, a waist and skirt combined, forming a foundation upon which dresses of various styles of drapery and trimming can be arranged. Corsets are discarded, though, for stout women, with flabby muscles, a "bosom support" is deemed allowable. The magazine is edited with taste and judgment, and its illustrations and mechanical work are attractive.

The Art of Projecting. By Professor A. E. Dolbear. Second edition. Illustrated. Boston: Lee & Shepard. Pp. 178. Price, $1.

Professor Dolbear has revised and made additions to this work in the edition just published. The chief parts of the new matter relate to the use of electric lamps and lights for projection purposes, and to the production and phenomena of vortex rings.

Richard Lepsius: A Biography. By Georg Ebers. New York: W. S. Gottsberger. Pp. 347. Price, $1.25.

This volume gives quite a full account of the university studies of Lepsius, and of the state of Egyptology when he devoted himself to it immediately after the death of Champollion. Then follow descriptions of his work in the collections of Egyptian antiquities in Paris, Italy, Holland, and England, and of the Prussian expedition to Egypt under his direction. Succeeding chapters present Lepsius as "the master-workman" and as a man, and the home of Lepsius. A list of his works is appended, and a portrait, with autograph, forms the frontispiece.

On teaching English, with Detailed Examples, and an Inquiry into the Definition of Poetry. By Alexander Bain. New York: D. Appleton & Company. Pp. 256. $1.25.

This volume includes a review of the prevailing opinions as to the proper mode of teaching English, with a critical estimate of their respective merits, the handling of which is of necessity controversial; a brief sketch of the rhetorical method, followed by a series of select lessons on the leading qualities of style, intellectual and emotional; and an inquiry into the definition of poetry, which is intended to fall in with the treatment of rhetorical principles, both in theory and in practice. In the first part, the author disputes the theory that Saxon words should be preferred to classical in writing, or that they are preferred in actual speech; discusses the order of words; and considers the art of weaving the various threads which enter into the composition of the narrative in such a way as best to preserve the harmony and balance of all the parts. An estimate is given of the value of the older writers, and their defects as standards in composition; the advantages and disadvantages of essay-writing, paraphrasing, and converting poetry into prose, as exercises, are measured; and the methods exemplified in Bacon's essays are analyzed as showing "how not to do it." A large proportion of the space is given to the "select lessons" illustrating the intellectual and emotional qualities of style, in which many complete compositions from the standards of English literature are dissected, analyzed, and criticised in detail, with especial reference to those characteristics. Poetry being regarded as a fine art, the source of its definition is sought in the sphere of the human emotions. In respect of matter, it is contrasted with science, oratory, morality, and religion; in respect to literary form, it is distinguished from history, narrative, description, and exposition, all of which, however, have their poetical aspects. And the pure romance, or novel, is considered "a species under the genus poetry, which must be so far widened as to include it."

Biographies of Words; and the Home of the Aryas. By F. Max Müller. London and New York: Longmans, Green & Co. Pp. 278.

Admitting that language and thought are inseparable, as the author has labored to show, it follows that all thoughts which have ever passed through the mind of men must have found their first embodiment and their permanent embalmment in words. If, then, we want to study the history of the human mind in its earliest phases, where, Professor Müller asks, can we hope to find more authentic, more accurate, more complete documents than in the annals of language? "Every word, therefore, has a story to tell us, if we can only break the spell and make it speak out once more. It is known that every word, if we can analyze it at all, is found to be derived from a root. It is equally well known that every root is predicative, that it predicates something of something, and that what it thus predicates is in reality an abstract or general concept. This applies to all languages, even to those of so-called savages, whenever they have been subjected to a really scholar-like analysis. . . . Every language, if properly summoned, will reveal to us the mind of the artist who framed it, from its earliest awakening to its latest dreams." In the light of these views, the history and fortunes of a certain number of words and expressions in common language are taken up and traced back through the various changes which the forms have undergone, as far back as possible toward their original Aryan roots. The chapters on "The Home of the Aryas" and "The Earliest Aryan Civilization" are devoted to the vindication of the theory that the original seat was in central Asia, as against the newly-proposed view that it was in northern Europe. These chapters are followed by a list of words in the seven principal languages of Aryan descent, which is intended to illustrate the argument. The appendices contain letters on the Aryan fauna and flora, the original home of jade, the original home of the soma, "philosophy *versus* ethnology," and a discussion whether copper or iron was the third metal. The author, with his warm enthusiasm, has a rare way of making the dry and abstruse theme on which he is engaged, despite the terrible-looking words and roots with which he illustrates his points, singularly attractive. We are pleased to see that he regards the labors of our Americans, Brinton and Hale, with others, as "every whit as important as the labors of Grimm, and Kuhn, and Pott."

The "How I was Educated" Papers. New York: D. Appleton & Co. Pp. 126. Price, 30 cents.

The pamphlet having the above title is a collection of autobiographical articles by Rev. E E. Hale, T. W. Higginson, W. T. Harris, and Presidents or ex-Presidents of Columbia College, the Chautauqua University, Dartmouth, Vassar, Yale, Brown, Michigan, and Cornell, which first appeared in "The Forum." As Mr. Hale wittily describes the articles, "The editor of 'The Forum' has thought that a series of papers, in which different people shall describe the methods of their school-education, may be at least amusing, and perhaps profitable, if only by way of caution. He has, therefore, induced a good many men to pose on his platform as 'awful warnings,' and, as it happens in the story of the Indian march, he selects a little elephant to lead the risky way down into the river."

Trees of Reading, Massachusetts. Part I. By F. H. Gilson. Reading: The Author. Price, $1.50.

Mr. Gilson has embodied a very attractive idea in a most tasteful manner. The pamphlet consists of heliotype views of five fine old trees — elm, sassafras, oak, and birch—standing in the town, near Boston, where the author resides, with a page of description and history of each one, and an introduction. The sheets are printed on one side only, with a liberal margin, and are not stitched. There is scarcely a village in the early-settled part of the country but has such trees, forming characteristic features of its landscape, and serving as memorials of interesting local events. Mr. Gilson photographed these trees, and collected the information about them in the first place for his own gratification; but, finding others interested, he has published a first installment of his material, and, if enough copies of this part are sold to pay expenses, other parts will follow.

Exact Phonography: A System with Connectible Stroke Vowel-Signs. By George R. Bishop. New York: the Author (at the New York Stock Exchange). Pp. 244. Price, $3.

The question of providing stroke vowel-signs, which could be written in with the consonants without lifting the pen from the paper, has engaged the attention of many phonographers, but the results have so far not been encouraging, and a conviction has arisen that, however desirable this feature might be, it was impracticable in a working short-hand. Mr. Bishop has, nevertheless, undertaken the task, and has made a serious, persistent, and ingenious attempt to conquer the difficulty. The measure of his success can not be accurately given; time and practical use will be necessary to settle that; but he may fairly claim now to have shown that the obstacle was not unsurmountable. That Mr. Bishop's work should attain the ultimate solution of the problem is not to be expected; but it is certainly an approximation, and probably furnishes the basis on which the perfected scheme will rest. The greatest gain to be derived from the stroke vowel-signs is in increased immediate legibility—a very important matter. This is given partly by increasing the list of alternate forms by means of which a somewhat arbitrary distinction may be effected between words that otherwise would require to be written alike and distinguished by the context, but chiefly by the ability to include a vowel which may be perfectly decisive of the word intended. The writer of the new system will frequently have the opportunity to choose whether he will sacrifice consonants or vowels; while heretofore no choice was left to him, provision having been made simply to throw out the vowels in all cases, to meet the requirement of speed. A mere consonant outline is frequently entirely devoid of suggestiveness, although perfectly unmistakable when the word to which it belongs is found. The lack of convenient vowel-signs also has probably helped to discourage the adoption of phonography as a medium of correspondence; the labor of inserting the vowels being irksome to the writer, and that imposed by their omission being still more irksome to the reader. Mr. Bishop's book is certainly worthy of attention from all who desire to become or to remain professional short-hand writers.

The Journal of Morphology. Vol. I, No. 1. September, 1887. Edited by C. O. Whitman, with the co-operation of Edward Phelps Allis, Jr. Boston: Ginn & Co. Pp. 226.

The establishment of a new scientific journal is a source of gratification to all who are sufficiently acquainted with the history of research in pure science to realize the assistance, both to further acquisitions and to practical applications of knowledge, which is afforded by making known the results of investigations. Accounts of the work of American zoölogists, the editor of the "Journal" remarks, are to be sought "in the various publications of the Smithsonian Institution, in voluminous reports of government commissions, in the memoirs and proceedings of societies and academies, in the bulletins and memoirs of a few universities, and in numerous periodicals devoted to the natural sciences." As no branch of science can make much progress until the care of specialists succeeds its fitful cultivation by investigators largely occupied with other subjects, so its literature is much less accessible and effective when scattered through a variety of scientific miscellanies than when concentrated in a special organ. The first number of "The Journal of Morphology" gives evidence that the previous lack of an American zoölogical journal, ably edited, and printed and illustrated in a liberal style, has now been well supplied. The number comprises the following seven papers: "Sphyranura Osleri, a Contribution to American Helminthology," by Professor R. Ramsay Wright and A. B. Macallum; "The Development of the Compound Eyes of Cranogon," by Dr. J. S. Kingsley; "Eyes of Mollusks and Arthropods," by Dr. William Patten; "On the Phylogenetic Arrangement of Sauropsida," by Dr. G. Baur; "A Contribution to the History of the Germ-layers in Clepsine," by C. O. Whitman; "The Germ-bands of Lumbricus," by Professor E. B. Wilson; and "Studies on the Eyes of Arthropods," by Dr. William Patten, all of which, except that on arrangement of Sauropsida, are accompanied by lithographic plates. The "Journal" is to be devoted chiefly to embryological, anatomical, and histological subjects, and will be practically limited to *animal* morphology. Each number will contain from 150 to 200 or more pages, and eight or ten lithographic plates. There will be no stated times of publication, but numbers will appear when the material on hand makes it desirable. This undertaking deserves that every American zoölogist should do his share toward insuring for it a continuance of life and usefulness.

Astronomy for Amateurs. Edited by John A. Westwood Oliver. Illustrated. London and New York: Longmans, Green & Co. Pp. 316. Price, $2.25.

This manual has a different field from that of books which aim merely to point out the beauties of the firmament. "Its pages are intended to afford the amateur astronomer, possessed of limited instrumental means, but yet anxious to devote his labors to the furtherance of astronomical science, such hints and suggestions as will help him to direct his efforts into the channels which experience has indicated as best fitted to his qualifications and equipment." The editor has had the assistance of eminent specialists in various departments of astronomy.

Ormsby Macknight Mitchel. By his Son, F. A. Mitchel. Boston: Houghton, Mifflin & Co. Price, $2.

This biography is a vivid panorama of the career of an enthusiastic astronomer and faithful general. The history and character of the subject have been presented, so far as possible, in the words of his diary and letters. The account of the founding of the Cincinnati Observatory, and of Professor Mitchel's visit to Europe to procure instruments, is almost entirely derived from his papers, but there was not sufficient material available for a complete life-record of this sort. The space devoted to his service in the civil war, limited by his death to fourteen months, about equals that occupied with his early life and his scientific work.

Natural Resources of the United States. By Jacob Harris Patton, M. A., Ph. D. New York: D. Appleton & Co. Pp. 523. Price, $3.

This comprehensive work presents in a single volume as full an account as the general reader will require of the many and varied natural products which are yielded by land and water in the United States. The first hundred pages are devoted to the coal-fields from Texas to Alaska, giving a brief section to each locality or variety, and including the leading facts of the geology of the carboniferous deposits. The coal-fields of Canada and Europe are also briefly mentioned. Petroleum and natural gas come next in order, and then iron-ores are treated of in the same manner as coal. The comparatively short chapters on gold and silver include accounts of the original discoveries in some of the most famous mining regions of the country. The other useful metals receive due attention. The chief deposits of precious stones, clays, building-stones, marbles, and abrasive materials are named, while such minerals as graphite, salt, sulphur, borax, mica, and asbestus are not forgotten. Among mineral resources medicinal waters of course have a place, and the account of these naturally leads up to a chapter on health-resorts. The consideration of the vegetable resources of the country is introduced by a description of its climate and rainfall. The fisheries, the fur-seal, and wild game are the chief resources belonging to the animal kingdom, while the people of the United States have two other great natural resources in water-power and unoccupied homestead lands. For the American or foreigner whose occupation or whose desire to be well informed gives him an interest in this class of facts relating to the United States, the volume is one that can be read with pleasure, and that will be frequently referred to. It should be in the library of every American consul, and the purchase of a sufficient number of copies to supply those officers would be a very proper transaction on the part of the State Department.

The New Astronomy. By Samuel Pierpont Langley, Ph. D., LL. D. Illustrated. Boston: Ticknor & Co. Pp. 260. Price, $5.

Readers of the "Century" magazine will give this handsome volume a cordial welcome without the formality of an introduction, for the chapters of which it is composed have appeared from time to time as illustrated articles in that periodical. Those who are not already acquainted with the fascinating style in which the author depicts the wonders of modern astronomy will derive even more pleasure from the book. In explanation of his title, "The New Astronomy," Professor Langley says that until very lately the prime object of astronomy has been "to say *where* any heavenly body is, and not *what* it is," but that, within a comparatively few years, a new branch of the science has arisen, "which studies sun, moon, and stars for what they are in themselves and in relation to ourselves." This branch of astronomy, sometimes called celestial physics, deals with the constitution, condition, and configuration of the sun, moon, and planets; of meteors, comets, and stars. The view of this field which Professor Langley gives is general rather than detailed, for his book is not addressed to the professional reader, but is intended to solicit for the "new" astronomy the interest and support of the educated public. It is admirably adapted to produce this effect. Its descriptions are picturesque without bending the lines of fact, and its language is vivid without being inaccurate. Ninety-three figures, many of them of full-page size, embellish the volume, and the paper, printing, and design of the cover are of the handsomest. Four of the eight chapters of the work are devoted to the sun. The author takes up first the spots on the sun, those immense blotches sometimes exceeding in extent the whole surface of our globe, and tells what is known as to their cause. He regards as not proved the idea that sun-spots have an influence on the weather, thereby affecting harvests on the earth, but a connection between the spots and terrestrial magnetic disturbances he deems sufficiently established. The sun's corona, as seen in eclipses, and the solar prominences are next described. In the two chapters on the sun's energy some idea of the quantity of heat radiated from the sun is given, and the question of how the solar fire is fed is discussed. The absolute dependence of all activity and life on earth upon the supply of heat received from the sun is pointed out, and the idea of a greater need for utilizing this heat in the future by means of solar engines is suggested. Of the planets, Saturn, Jupiter, and Mars are selected for special attention. The moon is described with gratifying fullness, and an excellent idea of its surface is given by the reproductions of lunar photographs, and of photographs of volcanic formations on the earth, and of other wrinkled and cracked surfaces, which are inserted for comparison. The phenomena of meteors and comets are presented in the same enthusiastic style which characterizes the rest of the book. The concluding chapter embodies some of the results of the application of the spectroscope to stellar research. The volume is an admirable one for the library of the cultured general reader, for it gives information without an array of figures which are as wearying to everybody but specialists as they are interesting to that class; it presents conceptions of the vast magnitudes, distances, and forces of the visible universe in the form in which they can be best grasped; and while it inspires a respect for the great results which have been accomplished by the genius and industry of modern astronomers, it also conveys a sense of the boundless regions of space beyond the range of their instruments, for the present unknown to earthly intelligence, and, perhaps, forever unknowable.

Half-Hours with the Stars. By Richard A. Proctor. New York: G. P. Putnam's Sons. Pp. 39. Price, $2.

The above-named edition of Professor Proctor's "Half-Hours" appears with maps and text specially prepared for American students. It is an atlas of twelve maps, showing the position of the principal star-groups throughout the year, with an explanation of each map, and an introduction.

THE EARTH IN SPACE. By EDWARD P. JACKSON. Boston: D. C. Heath & Co. Pp. 73. Price, 35 cents.

THIS convenient and copiously illustrated little manual comprises the facts in regard to the earth as a planet which are commonly included in text-books of geography, under the heading mathematical or astronomical geography, together with other matter in this most practical department of astronomy. It is designed for schools in which time can not be spared for a general course in astronomy.

MANAGEMENT OF ACCUMULATORS, AND PRIVATE ELECTRIC LIGHT INSTALLATIONS. By Sir DAVID SALOMONS. Third edition, revised and enlarged. New York: D. Van Nostrand. Pp. 150.

THIS little book is the result of the author's long experience with electric lighting, which was preceded by the use of a private gas-making plant on his own estate. He has used secondary batteries since they first became practicable, sparing no expense to obtain satisfactory results, and feels confident that his directions will make the seeking of professional advice rarely necessary.

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POPULAR MISCELLANY.

Out-Door Play for School-Girls.—Professor W. E. Anderson, in a paper on "The Physical Side of Education," forming part of the Wisconsin State Board of Health Report for 1887, makes a plea for the indulgence of school-girls in play. He says: "Our school-girls lead a life without play, in the real meaning of the term. Muscular exertion is confined entirely to locomotion, or to movements requiring exercise of the lower part of the body. The restrictions of dress are such that movement above the waist is out of the question. The vital organs are restricted by dress, fashion, and occupations supposed to be suitable to the sex. Notice the difference between the movements of boys and girls of the same age, and attending the same class. While the boys can engage in every species of activity, and practice some sports perhaps too grotesque to be permissible for the opposite sex, the girls of sixteen are satisfied with a stately walk around the block, two under one shawl, conning the next lesson to be heard after school is called. All this is certainly a perversion of what Nature requires. There is no reason why such different dispositions should be manifest between the sexes at this age. The avoidance of play or exercise, and the conventionalities of dress, explain in a large part the want of full and natural development so characteristic of the female sex at the age when they should present in every respect of form, health, and color, the picture of human physical perfection. As it is, the majority of them at twenty years of age are already pale and faded, unnatural in color, wanting in spirit and force, and give evidence of retarded or obstructed development. Where exceptions occur it is usually owing to a violation of the *régime* of the school. Many of our district schools are supplied with a large, well-lighted, and well-ventilated hall. This hall might be used every day in the week for systematic plays designed or contrived to call into active exercise the senses and the whole muscular system. The running leap of the German gymnasium should form a feature of the sports of this hall. Girls could loosen their waistbands and adopt a style of dress which would enable them to exercise their shoulders and arms. They might find in this practice healthful sport, and a means of developing the tissues of the arms and shoulders, which would result in the development of that beauty of form so highly prized and so frequently simulated by artificial means. The muscles of the hands and arms can be exercised by the play of grace-hoops, cast by the use of two wands, and caught in the same way. The game of shuttlecock, requiring the use of a light bat, alternately in the right and left hand, calls into activity sight and touch. It would not be difficult to contrive games of which young people would not grow weary, and which would without question insure for our feeble school-girls a more durable tenure of good health and a larger stock of force and endurance. While the school ignores the necessity of play to the young, society gives it questionable recognition, and that most potent ruler of society—Fashion—finds in it opportunities for the display of her power. Tennis and archery are resorted to for amusement, and would yield most abundant good exercise were these games not subordinated to such exclusively polite practice that the dress of the players is even one of the chief requisites to the successful conduct of the game. The amusement is captured by the dressmakers and dudes, so that even this means of exercise without flannel suits and rubber-soled shoes is not regarded as permissible. As in dancing, the accessories become so elaborate and costly, and beset with so many formalities, that physical recreation is not expected from it. The game merely answers as a scheme to bring people together who are hankering for some opportunity to be near each other, and exchange the sentimental platitudes of unsatisfied and instinctive social emotions. If Gustave and Regina, at fifteen years of age, are to be improved by scurrying about in the manner and time of the modern waltz, then 'twere well that the latter were dressed so as to give her freedom of limbs and lungs, and the recreation given in the afternoon, so that regular sleep at proper time may allow that recuperation of energy and nourishment of wasted tissue consequent upon exertion. As Wesley remarked in apology for the liveliness of Methodist singing, 'It is not right for the devil to have all the best tunes,' so it may be said of dancing, that recreative means should not be monopolized by the social usages and occasions where circumstances exclude the greatest benefit from the exercise, and sometimes induce positively injurious consequences."

What is a Glacier?—The Philosophical Society of Washington, some months ago, had a symposium on the question "What is a Glacier?" Mr. I. C. Russell, taking both the Alpine and continental types into consideration, would define a glacier as an ice-body, originating from the consolidation of snow in regions where the secular accumulation exceeds the loss by melting and evaporation, or above the snow-line, and flowing to regions where loss exceeds supply, or below the snow-line. Mr. S. F. Emmons described a glacier as a river of ice, possessed, like the aqueous river, of movement and plasticity. The *nevé* field is the reservoir from which it derives not only its supply of ice, but the impulse which gives it its first movement. Mr. W. J. McGee held that the phenomena of glacier ice and *nevé* ice appear to belong to a graduating series; and in consequence the two phases can only be arbitrarily discriminated. Mr. W. H. Dall defined a glacier as a mass of ice with definite lateral limits, with motion in a definite direction, and originating from the compacting of snow by pressure. Mr. T. C. Chamberlin, disclaiming attempts to give a rigorous definition, thought the better distinction between *nevé* and glacier was genetic. There is an area of growth and an area of waste in every glacier. Superficially the area of growth coincides with the *nevé;* the area of waste with the glacier proper. Mr. C. E. Dutton said there was little difficulty in recognizing a glacier when all those features that characterize it are present, and where the conditions are of the ordinary nature; but exceptional cases arise to make an exact definition impracticable.

The Beauty of Old Wrought-Iron Work.—Mr. J. Starkie Gardner has observed, in a Society of Arts lecture on "Wrought-Iron," that old iron-work possesses interest and attractions which few examples of modern work can equal. This is partly because, estimating by the eye and working his scrolls by hand, the workman "produced an irregularity and play in even the most monotonous design which is artistically charming to us, but was perhaps even a source of chagrin to him." The modern smith works in a different way, and turns out uniform rods and scrolls, while he considers any irregularity a sign of bad smithing. The scarcity of straight bars among the oldest examples was probably due to the fact that it was extremely hard to handle a long bar and beat it out perfectly true with mathematically exact and sharp angles. Another element of artistic superiority in the older work lay in the fact that it was intrusted only to persons who had a special aptitude; and, if such a person were not forthcoming, the work was either not executed, or was made in the simplest form; while, if he were at hand, the details of the design were left to his fancy, and were, therefore, well within his own powers. It was the existence of the skilled smith that created the demand, rather than the demand that created the smith; and it seems a reasonable inference that none such had to beg for work in the middle ages. When a grill was wanted for, say, Westminster Abbey, it was not the local man who had the commission, but a smith from wherever he might be found, who had a designing capacity and a skill of his own, who was fetched and maintained until the task was completed. The smiths of those days were probably not fettered by estimate or bound by time; but, we have a right to suppose, the art-work was produced for art's sake by a genuine artist.

New Kinds of Optical Glass.—Professor Abbé, of Jena, has been experimenting for many years with a view to produce an optical glass which should be free from the defects incidental to all silica glasses. In particular, he sought to produce a higher degree of achromaticity than was hitherto possible, by diminishing the secondary coloring effects inseparable from the ordinary silicate flint and crown glasses, and to produce a greater multiplicity in the gradations of optical glass in respect of the two great constants of the index of refraction and the mean dispersion. In silicate glasses, those two constants increase and decrease together. Cases often arise in which a different relation is desirable. Professor Abbé has produced glasses in which both objects are fulfilled. He has produced achromatic lenses of a more perfect kind than were ever before obtainable, and has introduced a whole series of new glasses of graduated properties. These glasses are offered freely to the trade without any restriction or patent being allowed to stand in the way of further development.

How the Krakatoa Dust was carried.—Mr. Ralph Abercromby introduces an account of his studies of the relation of the upper wind-currents near the equator, with the diffusion of Krakatoa dust, by showing that, as a rule, there is a continuous successive veering of the equatorial winds as we ascend. Standing with one's back to the surface wind, the upper currents will—north of the equator—come successively more and more from the left with increasing height; south of the equator, the rule is reversed. Nevertheless, some remarkable variances have been observed in the region between the equator and the doldrums. From the consideration of these exceptional cases the author concludes that when the trades or monsoons meet they do not interlace, as has been suggested by many, but the upper winds combine in a generally easterly current, and probably diverge only slightly pole-ward on either side. The velocity of this current is unknown. Applying this theory to the dust-flow from Krakatoa, as its advance was indicated by the view of green suns and red after-glows, the system of its movement will appear to have been very simple. "The great dust-stream was carried for the first twenty-four hours by the normal easterly upper currents over the south-east trade, at the extraordinary rate of more than one hundred and twenty miles an hour, but hardly extended north of the line. . . . In fact, we may say that the great stream of Krakatoa dust was carried nearly round the world by the usual upper winds of the south-east trade, in which the dust was first ejected at a rate of about one hundred and twenty miles an hour, and that the dust spread very slowly either north or south of the main current." The high velocity of one hundred and twenty miles an hour is certainly more than would have been expected; but, while we have very few observations of the rate of motion of the highest clouds, a number of those that we have give figures approaching this speed. So that the author is able to add: "There would be nothing, then, outrageous in the assumption of a velocity of one hundred and twenty miles an hour for the easterly current over the equator to account for the high speed of the diffusion of Krakatoa dust; and it is also satisfactory to know that the general direction of the flow is in accordance with the most recent researches on the vertical succession of the upper currents near the equator."

The Crater-Lake Chala.—Mr. J. A. Wray last year reached the edge of the water of the crater-lake Chala, on Mount Kilimanjaro, which Mr. Thomson saw and has described in his account of the mountain. The lake is about three miles long by one mile wide, with banks so steep that a descent to the water is impossible, except at one place on the western side. Mr. Wray found the water clear, cool, and perfectly sweet, though the lake has no apparent inlet or outlet. It contains fish, and numerous water-fowl were swimming on its surface, the flapping of whose wings, when they took to flight, produced a sound, through confused reverberation in the deep, well-like basin, like the rushing of a distant railway-train. The steep banks, about one thousand feet in height, are well wooded, and vegetation clothes their surface down to the water's edge. There is no mark of higher water, and it probably keeps the same level all the year round. The cries of birds had a peculiar sound, and Mr. Wray believed that it is these noises that have given rise to the native myth that a Masai village formerly stood here, which was swallowed up by the lake. The people of Taveta believe that they hear voices, the lowing of cattle, etc.

Black Bears.—Mr. William Pittman Lent gives an interesting account of the "Black Bear" in the "Transactions" of the Ottawa (Canada) Field Naturalists' Club. The young of bears are produced in March, and no female has been killed by Canadian hunters, before or after the hibernating season, that showed any evidence of being in the gravid state. The cubs are very small—not larger, when two days old, than kittens of the same age. The animals feed principally on vegetable food—grapes, roots, berries, beechnuts, oats, and Indian corn. They sometimes visit the oat or corn fields before sunset, and may be taken there by a skillful hunter. They are inordinately fond of honey, and they feast luxuriously in the fall on the berries of the mountain-ash. When their natural food is scarce they visit the farm-yard and carry off pigs and sheep, and will even kill young cattle when pressed for hunger. They are also fond of fish; they have been known to wade and swim in the rivers for the purpose of catching them, and are frequently to be seen along the coast of the island of Anticosti, devouring herring-spawn. They are active, though clumsy, and will run for a mile or two with astonishing speed. When closely pursued by dogs, a bear will take to a tree, up which he can climb rapidly, but from which he descends more slowly, head upward, as soon as it appears safe to do so. They are very shy and timorous in the presence of man, and will make off rapidly when they perceive a human being by sight or scent, but they are most affected by the scent. The black bear fights with teeth and claws, and by hugging. When in an erect position he is a perfect master of the art of self-defense, and it would puzzle a pugilist to get in a blow at him. His most vulnerable part is the nose, which is provided with many sensitive nerves intimately and directly connected with the brain. When a bear is standing on all-fours, there would be no difficulty in striking him with a club; but, when he is sitting erect, it would be an entirely different matter. In Canada black bears retreat to their dens—generally under the roots of large trees, or occasionally in rocky caves—at about the setting in of the season of confirmed frost and snow. They remain there in a quiescent state, although not—as has been well established by hunters who have killed them in their dens in the depth of winter—in a trance-like condition of torpidity, till the opening of spring. When they first emerge from their four months' slumber they are heavy and fat, and their fur is in prime condition, but shortly afterward they fall off in flesh, and soon become ragged in coat and lanky in appearance. Toward October, if they have had a favorable summer, they are found in good condition, and at any time after the middle of November their skins have the finest color, and the thickest and heaviest coat of fur. Bears are still found within eight or ten miles of the city of Ottawa. Even the black bear, Mr. Lent thinks, is of sufficient importance in the economy of Nature and of man to entitle him to legal protection.

Useful Reptiles.—When we have secured protection to the birds, it will be time to teach the people to have more mercy on the reptiles. The popular, almost unconquerable prejudices against this class of animals are regarded by science as mistaken except as to a very few kinds, but the public still need enlightenment on the subject. Professor O. P. Hay has embodied a popular lesson on the innocence and even value of most reptiles in his paper on "The Amphibians and Reptiles of Indiana," which, being comprised in the State Agricultural

Report, will reach all the inhabitants of at least one commonwealth. "Many amphibians and reptiles," he says, "are of direct value to man. Many, as various kinds of turtles and frogs, are used as food, and such might even be profitably bred for that purpose. Many others are useful because of their propensity for devouring insects, mice, and rats, that are the pest of the farmers. A few, indeed, are dangerous; but it is worth any person's while to study our reptiles, if for no other reason than to be freed from constant fear of them. Of nearly a hundred species of amphibians and reptiles to be found within Indiana, not more than three or four are poisonous, and these are of rare occurrence. . . . Some others may strike, or bite a little, or constrict, as they have a right to do, but they are not venomous, and can do little hurt. Snakes that roll along like hoops, snakes that blow poison, snakes that sting with their tongues or the tips of their tails, and snakes that live for weeks in people's stomachs, are creatures of the imagination. Therefore, considering their usefulness as destroyers of vermin, no amphibian or reptile ought to be killed, unless it is to be employed for practical uses or preserved as a specimen for scientific purposes. . . . If the boys of the country are to be allowed to shoot all the birds and stone to death all the reptiles, we may yet be compelled to surrender to the vermin."

How the Glacial Drift was deposited.—The manner in which the glacial drift was deposited by the great ice-sheet has been studied by Professor O. P. Hay as a problem whose solution has not yet been effected. One of the difficulties in the way of comprehending it originates in the fact that all our analogies are derived from the observation of modern glaciers in motion down steep inclines, while we do not fully recollect that the great glacier in question most probably came to a standstill in level territory. Bearing this point in view, the author concludes that a glacial ice-sheet moving over a nearly level surface would possess far less power of abrading its bed than the same glacier would have while descending a slope of high angle; through subsidence of the glacial mass, caused by the earth's heat, and through other influences, a constantly increasing proportion of inert materials would collect in the lower layers of the moving ice; the accumulation of such materials would tend to retard the motion of the lower portions of the glacier, and, finally, when they formed a sufficiently great proportion of the mass, all motion of the lower portion would cease, and a permanent deposit would begin and continue to be made; other masses of detritus might be deposited at the foot of the glacial ice-sheet as a terminal moraine, and still other masses on the top of the already formed deposit when the glacier finally melted.

Mineral Constituents of Food.—In considering the different food-stuffs, says Dr. N. A. Randolph, we must regard water as of prime importance. In the average adult it constitutes from fifty-nine to sixty-five per cent—or even larger proportions, according to other estimates—of the entire weight. We must regard it as an essential condition for the manifestation of all total phenomena. Certain solid inorganic elements of food are also essential to the well-being of the organism, for in their absence the tissues can not be properly built up, nor can the processes in either the solids or the fluids of the body go on. The presence of mineral constituents appears absolutely essential to the integrity of proteid matter, and their withdrawal entails a loss of most of its distinguishing characteristics. A striking illustration of the necessity of this class of food-stuffs, and of the disturbances resulting from a very slight diminution in the amount of inorganic constituents present in the economy, may be found in the recent experiments of Ringer. Minnows, which thrived in brook-water, and remained alive in it without food for many days, died in a few hours when placed in distilled water properly aërated. Examined more closely in detail, the inorganic elements of food consist of the salts of the alkalies, salts of the alkaline earths, iron, silica, and fluorine in various combinations. The importance to the economy of the carbonates of the alkalies, and therefore the importance of fresh vegetable food from which they are most readily elaborated, must not be under-estimated. Of the uses of potassium chloride but little is known. Sodium chloride, however, or common salt, has been more closely studied. In such proportions as the healthy taste demands, it is undoubtedly a valuable stimulant to the nutritive processes. The extent of the need for lime-salts in young animals is surprising. Iron is undoubtedly a food; for the quantity in the system is restored as fast as it is eliminated. Contrary to popular belief, the major portion of the iron of the human body is found, not in the blood but in the muscles, even after their contained blood has been removed. Silicic acid is found in very small quantities in bones, hair, and blood. It is supplied by many vegetable foods. Calcium fluoride is found in teeth, and to a slight extent in bone. Fortunately for us, these inorganic foods, whose withdrawal exercises deleterious influences on the economy, are, as a rule, present in great quantity in the actual foods in a mixed diet. In certain methods of preparing foods, however, their proportion is much diminished; thus, in the boiling of meats and vegetables, a large quantity of these important foodstuffs is extracted. Indeed, one of the chief dietetic advantages of salads and uncooked vegetables in general is, that these elements have not been removed.

Why do our Teeth decay so fast?—To this question Dr. Julius Pohlman answers, because we do not use them enough—showing that as a rule "those people who are least acquainted with the so-called hygiene of the teeth are the happy possessors of the soundest dentition"—like the negroes who chew sugar-cane, the German peasants, who are famous for their brilliant "Schwartzbrot-Zähne," or "rye-meal-bread teeth," polished but not worn out by daily mastication of dry, hard, black loaves, and the few old people left among us who persist in eating bread-crusts. Our weak and effeminate teeth are not used to hard work, and, like other organs that are not exercised, tend to atrophy. "The foundation for bad teeth," says this author, "is generally laid in early childhood; for numberless mothers and nurses very carefully soften the food or remove the crust from the bread before giving it to the little folks, because it may otherwise 'hurt their teeth,' and so the child grows up with a set of unused organs in its mouth; and when we have finally succeeded by the creation of artificial conditions in producing weak organs, then we wonder why the poor child has such bad teeth, and why it is so often suffering with toothache, and why the dentist's bill is so high. Teeth are organs specialized to perform the work of mastication; they are subject to the same laws that govern other organs, and their strength is determined by their use. Understanding this, we are obliged to admit that, if we ever become a toothless race, it will be our own fault."

Antiseptic Properties of Coffee.—The stimulating effects of the infusion of coffee have been referred to its excitant and tonic properties. Recent researches indicate that it has still more valuable qualities—those of an antiseptic. In 1885 M. Oppler announced the property which it possesses of preventing, to a certain extent, the development of micro-organisms in substances liable to putrefy. Then M. Sucksdorff showed that infusions of coffee and of tea might remain exposed openly to the air for a considerable time without molding or developing bacteria. Finally, Mr. Heim has recently published the results of more exact researches, which tend to demonstrate the reality of the antiseptic properties of roasted coffee. The cholera bacillus appears to be one of the organisms most readily affected by coffee. It is desirable to have the investigation extended to the infusion of tea, which will probably be found to have similar properties.

A Crystal Skull.—Among the interesting features at the meeting of the American Association was the exhibition, by Mr. George F. Kunz, of a crystal skull which had been brought from Mexico by a Spanish officer before the French invasion, and, having been in possession of Mr. Evans, the English collector, and Mr. M. E. Boban, now belonged to Mr. George H. Sisson, of New York. The inclusions in the rock-crystal material were identical with those in the quartz or rock-crystal from Calaveras County, California. Nothing more than this is known of the origin of the skull. It is not Chinese, or nature would have been more faithfully copied; nor European, for the work would have been more carefully finished. Professor Morse, who has resided in Japan, and Mr. Tatin Basha, a Japanese, aver that it is not of that origin, Mr. Basha remarking that a skull is not considered a fit decorative object in Japan. Large masses of crystal have been found in the California locality, and small skulls made of the same material, measuring rarely more than two inches across, have often been brought from near Pachuca, in the State of Michoacan, Mexico. The skull weighs one hundred and seventy-five and one quarter ounces. The eyes are very deep hollows. The line separating the upper from the lower set of teeth has evidently been produced by a string, either held in the hand or stretched across the bow, and is very characteristic of Mexican work. The skill of these people in making such objects has been questioned, but the large masks, mirrors, and other articles of obsidian; the objects of agate, and the numerous jade and jadeite ornaments; and the fact that they made small skulls of rock-crystal and skulls inlaid with turquoise—to the fashioning of which the making of this skull was as nothing—all indicate that they might have made a large skull if a suitable stone came into their possession. Since they procured their turquoise from Los Cerilles, New Mexico, why should we doubt that they were acquainted with the California locality for rock-crystal?

The Nest of the "Purse-Web" Spider.—Among the natural-history papers read in the British Association was one by Dr. H. C. McCook, describing the nesting habits of the spider *Atypus niger* of Florida, a species which it has been found was first observed and figured, as the "purse-web spider," by John Abbott, in 1792. The nests of the Atypus are silken tubes of close texture and various lengths and sizes, which are spun against the bark of trees in nearly equal proportions above and below the surface of the ground. Some of the tubes are from twelve to fourteen inches long, and from one half inch to three quarters inch in diameter; others—the nests of the young—are a few inches long and of the thickness of a pipe-stem. The inside of the nests is white and clean; the outside is weather-stained and covered with sand. In spinning these tubes the spider first stretches a series of straight threads from a point on the bark about an inch and a half above the ground. These lines are more or less approximated, and present the appearance of a rough framework for the tube. Upon them the architect places a thickening of spinning-work, which is beaten down and spread over by the long spinners, the process resembling more that of a plasterer than of a weaver. The work is done in small sections, until the original frame is quite covered in. The lengthening of the tube is accomplished by adding to the original section until the desired length is attained. The new-made tubes were found covered on the outside with sand. The spiders were not seen in the act of sanding their nests, but a similar habit in *Atypus piceus* of England has been observed and described by Mr. F. Enock, who has discovered that the sand is forced through the texture of the web from the inside. The idea of mimicry has been advanced in connection with this nest-sanding. Certainly the tube does closely resemble the tree to which it is attached. But Mr. Enock's observations indicate that the spider has taken a convenient way of getting rid of the sand brought up by its mandibles from the excavations of its burrow below the surface.

Insects resembling Minerals.—Mr. Edward B. Poulton, discussing the resemblances which certain insect-pupæ seem to bear in color to the surface on which they are found, thinks it probable that the gilded pupæ of *Vanessidæ* (butterflies) resemble glittering minerals, like mica, which is very common in many places. Their shape is very angular, and like that of minerals. Conversely, the gray pupæ resemble gray and weathered rock-surfaces; and the two conditions of rock would themselves act as a stimulus for the production of pupæ of corresponding color. The power was probably gained in some dry, hot country where mineral surfaces do not weather quickly. Once formed, it may be used for other purposes, and in certain species probably conveys the idea to enemies that the insect is inedible. It is interesting to note how the *Vanessidæ*, primarily colored so as to resemble mineral surroundings, are modified for pupation on plants.

NOTES.

That teachers are alive to the defects of existing systems of public instruction—for which they are not usually responsible—is shown in the criticisms made against them by Mr. George L. Guy, in his address before the Southern Illinois Teachers' Association: "Are the young women of our time," he asks, "trained in those things which mothers most need to know? Are they being prepared properly for domestic life? If not, the vigor and happiness of the individual and of the race must diminish, and the educational system that has neglected the essential elements of a woman's life must take its place with other useless excrescences. . . . Does our bookish education, in any sense, fit our young people to enter upon the practical duties of life? Clearly it does not. Our method of instruction must be molded by a more thorough knowledge and consideration of the real needs of every human being."

Experiments in tasting are reported in the "Transactions" of the Kansas Academy of Science as having been performed by E. H. S. Bailey and E. C. Franklin upon forty persons, to determine the relative bitterness of different substances. Strychnine led the list of seven vegetable bitters. The average results in each case are represented in the following series: Of salicine it is possible to detect one part in 12,000 parts of water; of morphine, one in 14,000; of quinine, one in 76,000; of quassine, one in 90,000; of picrotoxine, one in 197,000; of aloine, one in 210,000; and of strychnine, one in 826,000. Twelve of the tasters were able to detect one part of strychnine in 1,280,000 parts of water.

The great industrial institution in Berlin, according to the account of Professor Sylvanus P. Thompson, occupies a very large building, which is situated in a domain of about twelve acres. It is aided by the state, and gives instruction in every known industry. It has about 500 rooms for technical teaching, and a good library. It cost, all fitted out, $4,800,000, or about as much as a British ironclad, and is maintained at an expense of about $190,000. This expenditure and the original outlay are recouped by the well-to-do character of the pupils who pass through its teaching, and become useful members of society instead of burdens and pests.

A curious story of "A Reasoning Lobster" is told by Willard Nye, Jr., in the "Bulletin" of the United States Fish Commission. The sagacious crustacean's home was under a rock in Buzzard's Bay, in water about five feet deep. The author carefully adjusted a noose over the hole, and baited it with a piece of menhaden. The lobster passed its claw through the noose to get the bait; and the noose was drawn upon the claw, but slipped off when the animal had been pulled half out of his hole, and he escaped. The noose was fixed again, but this time, instead of putting out his claws as before, the lobster first put his feelers through the noose, felt the string all the way around, and then pushed one claw under the string and seized the bait. The experiment was repeated several times, but every new setting of the trap was met in the same deliberate way, as if by one who had thought the matter out.

The gypsies of Transylvania, according to a writer in "Blackwood's Magazine," teach young bears to dance by placing the animal on a sheet of heated iron, while the trainer plays on his fiddle a strongly accentuated piece of dance-music. The bear, lifting up its legs alternately to escape the heat, involuntarily observes the time marked by the violin. Later on the heated iron is suppressed, when the animal has learned its lesson; and whenever the gypsy begins to play on the fiddle, the young bear lifts its legs in regular time to the music.

It is said that forty per cent of all the deaths from poison in Great Britain are due to opium; and this rate of mortality, according to Dr. Wynter Blythe, "arises in a great measure from the pernicious practice, both of hard-working English mothers and the baby-farmer, of giving infants 'soothing-sirups,' 'infants' friends,' and the like, to allay restlessness and keep them asleep during the greater part of their existence." It has been calculated that one preparation alone is the undoubted cause of death of 150,000 children every year.

Professor W. Mattieu Williams convicts the enemies of physiological experiment of inconsistency by showing that all male animals that come fully grown to market, as they must know, are subjected to one of the most painful mutilations that can be performed, merely to improve the flavor of their flesh. "A prominent member of the screeching sisterhood," he says, "has been seen lounging in her carriage drawn by a pair of horses that have been thus tortured for her luxurious convenience. To this she is supremely indifferent, but raves most virtuously against those who puncture the skin of a dog or rabbit in order to save thousands of human beings from cruel disease."

Mr. Harris, of the Institute of Civil Engineers, contradicts the belief, which is general, that mine-explosions are always accompanied by a low barometer. Very few of the explosions of 1886 and 1887 were thus accompanied; and out of the list of disasters in the eleven years 1875–'85, given by Sir Frederick Abel, only 18·75 per cent of the accidents and 17·4 per cent of the deaths occurred when the mercury was at 29½ inches or below. One half of this small percentage of explosions took place with a low but rapidly rising barometer, when gas had begun to issue from the strata.

Mr. Francis Galton has described his ideal of an anthropometric laboratory as a place where a person may have any of his various faculties measured, and where duplicates of his measurements may be preserved as private documents. Besides the ordinary simpler apparatus, such an institution should contain instruments for psycho-physical research, for determining the efficiency of each of the various senses and certain mental constants. Instruction might be afforded to those who wish to make measurements at home, together with information about instruments and the registration of results. A library would contain works relating to the respective influences of heredity and nurture. It might also fulfill a welcome purpose as a receptacle for biographies and family records.

Otto Wiener, having made certain measures of the thickness of a film of silver which can just be perceived by the eye, concludes that 0·0000002 of a millimetre is an upper limit of the diameter of a silver molecule.

Mr. W. H. Preece said, in papers read in the British Association on "Copper Wire," with particular reference to its use in telegraphy and telephony and high-speed telegraphy, that the speed of transmission on inland circuits had increased from eighty words per minute in 1870, to six hundred in 1887, and on the most difficult line to Dublin, from fifty words in 1870 to four hundred and sixty two in 1887. In fact, as many words could now be transmitted on one wire as on nine in 1870. Those improvements had been the results of greater perfection in apparatus, the elimination of electro-magnetic inertia, the improvement of the circuits (the wire and its surroundings), and the introduction of high-speed repeaters.

OBITUARY NOTES.

George W. Tryon, Jr., the distinguished conchologist, died at his home in Philadelphia, February 5th. He was conservator of the conchological collections of the Academy of Natural Sciences of Philadelphia, which is said to outrank even those of the British Museum, and was himself the owner of the most numerous collection in the world. He spent the later years of his life in arranging and systematizing the Academy's collection. He prepared the "Manual of Conchology, Structural and Systematic," which, although it has reached its fourteenth volume, is left unfinished. He was the author of a work on the marine conchology of the eastern United States and of a general manual of recent and fossil conchology, and was one of the founders and editor of the "American Journal of Conchology." His fame was world-wide, and his standing among conchologists in the highest rank.

Dr. Joseph B. Holder, Curator of the American Museum of Natural History, died suddenly at his home in this city, February 28th. He had been connected with the museum for several years, and had taken an important part in the arrangement and classification of its collections. He was a frequent writer on subjects connected with his lines of work, being the author of many articles in public journals, magazines, and scientific periodicals, and of books.

Emil Rousseau, a French chemist, died in Paris, February 4th, in the seventy-fourth year of his age. After working in the laboratories of Orfila and Dumas, and in the Central and Municipal Schools, he established a manufactory of chemical products, at which subsequently Sainte-Claire Deville and Debray with his aid worked out the industrial fabrication of aluminum. He first applied pyrites to the fabrication of sulphuric acid, introduced a new preparation of charcoal, and devised the sugar process known as the Rousseau process.

The death is announced of Dr. J. T. L. Boswell, a well-known English botanist, who was for many years Curator to the Botanical Society in London.

Anton de Bary, the eminent botanist of the University of Strasburg, died January 19th after a painful illness. He was born in 1831, was Professor of Botany successively at Freiburg, Halle, and Strasburg, was famous for his researches on the algæ and fungi, was for many years after 1867 editor of the "Botanische Zeitung," and was the author of numerous treatises chiefly relating to cryptogamic vegetation, physiology, and morphology.

Mr. George Robert Waterhouse, late keeper of the department of geology in the British Museum, died on the 21st of January, in the seventy-eighth year of his age.

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Books noticed:

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