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EDITED BY

WILLIAM JAY YOUMANS

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GABRIEL DE MORTILLET.

APPLETONS' POPULAR SCIENCE MONTHLY.

VEGETATION A REMEDY FOR THE SUMMER HEAT OF CITIES.

A PLEA FOR THE CULTIVATION OF TREES, SHRUBS, PLANTS, VINES, AND GRASSES IN THE STREETS OF NEW YORK FOR THE IMPROVEMENT OF THE PUBLIC HEALTH, FOR THE COMFORT OF SUMMER RESIDENTS, AND FOR ORNAMENTATION.[1]

By STEPHEN SMITH, M.D., LL.D.

One of the most prolific sources of a high sickness and death rate in the city of New York is developed during the summer quarter. It has been estimated that from three to five thousand persons die and sixty to one hundred thousand cases of sickness occur annually in this city, from causes which are engendered during the months of June, July, August, and September. An examination of the records of the Health Department for any year reveals the important fact that certain diseases are not only more frequent during the summer quarter than at any other time, but that they are far more fatal, especially in the months of July and August, than during any [Pg 434] other period of the year. These are the "zymotic diseases," or those depending upon some form of germ life. The following table illustrates the course of mortality from those diseases in one year:

Month.	Deaths.	Month.	Deaths.
January	541	July	1,433
February	475	August	1,126
March	476	September	791
April	554	October	522
May	584	November	460
June	798	December	504

It appears that during eight months of the year, excluding June, July, August, and September, the average monthly mortality from "zymotic diseases" was 452. Had the same average continued during the remaining four months the total mortality from those diseases for that year would have been 4,424; but the actual mortality was 7,764, which proves that 3,340 persons were sacrificed during those four fatal months to conditions which exist in the city only at that period of the year. Still more startling is the estimate of the sickness rate caused by the unhealthful conditions created in the summer months in New York city. If we estimate that there are twenty cases of sickness for every death by a zymotic disease there were 66,800 more cases of sickness in the year above referred to than there would have been had the sickness rate been the same in the summer as in the other months of that year.

One of the saddest features of this high sickness and death rate appears when we notice the ages of those who are especially the victims of these fatal diseases. During the week ending July 9th last there were 399 deaths from diarrhœal diseases, of which number 382 were children under five years of age. The following table taken from the records of the Health Department show in a very striking manner how fatal to child life are the conditions peculiar to our summer season:

Month.	Deaths from Diarrhœal Diseases.			
	Under one year.	Under two years.	Under five years.	All ages.
January	50	55	58	82
February	47	51	58	75
March	75	80	83	96
April	82	91	97	108
May	101	117	121	104
June	387	430	436	467
July	809	990	1,020	1,100
August	464	565	697	762
September	267	394	409	462
October	114	148	154	190
November	59	70	72	89
December	57	62	64	82

These statistics demonstrate the extreme unhealthfulness of New York during the summer, and the vast proportion of children who perish from the fatal agencies which are then brought into activity. It is a matter of great public concern to determine the nature of the unhygienic conditions on which this excessive mortality depends, and thus discover the proper remedial measures. [Pg 435]

As high temperature is the distinguishing feature of the summer months, we very naturally conclude that excessive heat is a most important factor, if not the sole cause, of the diseases so fatal to human life at this period. A close comparison of the temperature and mortality records of any summer in this city demonstrates the direct relation of the former to the latter. For illustration, we will take the records of the Health Department during the past summer, selecting diarrhœal diseases for comparison, as they prevail and are most fatal at that season of the year. The table gives the total mortality from these diseases and the mortality from those diseases of children under five years of age. To the four months, June, July, August, and September, are added May and October, for the purpose of showing the gradual increase of the mortality from these diseases as the hot weather approaches and its decline as the hot weather abates.

Week ending	Total diarrhœal diseases.	Diarrhœal diseases under five yrs.	Mean temperature (Fahrenheit)	Maximum temperature (Fahrenheit)	Minimum temperature (Fahrenheit)
May 7th	10	8	52.4°	72°	47°
May 14th	20	17	55.5°	71°	40°
May 21st	14	12	63.3°	86°	52°
May 28th	22	19	60.9°	70°	56°
June 4th	18	16	65.8°	76°	54°
June 11th	26	20	71.6°	86°	58°
June 18th	36	32	73.0°	89°	59°
June 25th	74	69	69.3°	94°	54°
July 2d	170	164	78.6°	94°	67°
July 9th	399	382	77.4°	100°	61°
July 16th	330	321	71.1°	91°	57°
July 23d	388	356	77.4°	91°	67°
July 30th	380	353	78.5°	95°	70°
August 6th	380	353	78.8°	92°	67°
August 13th	342	306	73.9°	90°	65°
August 20th	290	261	74.8°	89°	64°
August 27th	268	246	76.6°	93°	63°
September 3d	289	256	79.0°	93°	59°
September 10th	283	255	74.0°	92°	58°
September 17th	179	158	67.3°	85°	52°
September 24th	193	167	68.7°	90°	52°
October 1st	132	117	66.5°	80°	54°
October 8th	90	78	69.6°	81°	53°
October 15th	71	58	60.1°	74°	49°
October 22d	54	42	55.9°	71°	44°
October 29th	39	32	53.9°	67°	41°

Again, if we compare the temperature and mortality records for a series of days instead of months, it will be noticed that the mortality record follows the fluctuations of the heat record [Pg 436] with as much precision as effect follows cause. The summer heat generally begins about the 20th of June and continues with varying intensity until the 15th of September. Within that period we can select many examples which strikingly illustrate the relations of temperature to mortality. For example, the first heated term of the year before us began on the 19th of June and lasted until the 26th of that month. The two records are as follows:

Day.	Temperature.	Mortality.
19th	78°	83
20th	80	100
21st	82	122
22d	80	116
23d	77	104
24th	68	119
25th	65	88

On the 28th of June a second heated term began, when the temperature rose to 80°, and continued above that figure until July 5th, a period of eight days. The following is the record, including the temperature in the sun:

TEMPERATURE

Day.	In shade.	In sun.	Mortality.
June 28th	80°	118°	118
June 29th	84	120	163
June 30th	85	124	191
July 1st	88	125	247
July 2d	87	128	351
July 3d	82	120	238
July 4th	84	122	227
July 5th	80	121	184

It will be noticed that during the last heated period there was a more prolonged high temperature than during the first, and that the mortality of the second was higher for the same temperature than that of the first. These facts are in accord with the history of our summer months. The range of temperature increases as the season advances, and the rate of mortality rises, owing to the diminished resisting power to the effects of high heat on the part of the people, especially of the children, the aged, and those already enfeebled by disease.

In order to fully understand the influence of heat and its effects upon the public health, we must first notice the conditions regulating the temperature of the body in health and disease.

The temperature of animals in a state of health is not a fixed quantity, but has a limited range which depends upon internal and external conditions not incompatible with health. In man the [Pg 437] range of temperature in health is fixed at 97.25° F. to 99.5° F. Any temperature above or below these extremes, unless explained by special circumstances not affecting the normal condition of the person, is an indication of disease. This comparatively fixed temperature in health is a remarkable feature of the living animal. When subjected to a temperature above or below the extremes here given it will still maintain its equilibrium. This fixed temperature under varying conditions of heat and cold is due to a "heat-regulating power," inherent in the constitution of every animal, by which it imparts heat when the temperature of the air is high and conserves heat when the latter is low. The heat escapes from the body—1, by radiation from the surface; 2, by transmission to other bodies; 3, by evaporation; and 4, by the conversion of heat into motion. The surface of the body furnishes the principal medium for the loss of heat by the first three methods—viz., radiation, transmission, and evaporation. It is estimated that 93.07 per cent of the heat produced escapes by the processes of radiation, evaporation, conduction, and mechanical work. The remaining heat units are lost by warming inspired air and the foods and drinks taken. There are apparently other subtile influences, so-called "regulators of heat," at work to preserve an equilibrium of temperature in the animal body, but they are not well known. The result of the operation of these forces is this—viz., if, by any means, the heat of the body is increased, compensative losses of heat quickly occur, and the normal temperature is soon restored; and if, on the contrary, the loss of heat is unusually increased, the compensative production of heat of the body at once follows, and the equilibrium is at once restored. The important fact to remember is this—viz., the production and loss of heat in the human organism when in health and not subjected to too violent disturbing causes are so nicely balanced that the temperature is always maintained at an average of 98.6° F., the extremes being 97.25° F. and 99.5° F. "So beautifully is this balance preserved," Parkes remarks, "that the stability of the animal temperature in all countries has always been a subject of marvel." If, however, anything prevents the operation of the processes of cooling—viz., radiation, evaporation, and conduction—the bodily temperature rises by the accumulation of heat, and death is the result from combustion. In experiments in ovens a man has been able to bear a temperature of 260° F. for a short period, provided the air was dry so that evaporation could be carried on rapidly. But if the air is very moist, and perspiration is impeded, the temperature of the body rises rapidly, and the person soon succumbs to the excessive heat. Another important fact is this, viz., the normal temperature of the young and of the very old is higher than the middle-aged. The infant at birth has a [Pg 438] temperature of 99° F. to 100° F., and it maintains a temperature of 99° F. and upward for several days. The variations of temperature from other causes are much greater in children than in adults, as also the normal daily variations of temperature. About the sixtieth year the average temperature of man begins to rise, and approximates that of the infant. In the young and old the "heat-regulating power" is more readily exhausted, and hence continued high temperature is far more fatal to these classes.

The first noticeable fact in regard to bodily temperature in disease is that there are daily fluctuations as in health, but much more extreme. In general, the remission of temperature in disease occurs in the morning, and the exacerbation in the afternoon and evening; the minimum is reached between six and nine o'clock in the morning, and the maximum between three and six o'clock in the evening. In many diseases the minimum temperature is not below 100° F., and usually it is one or two degrees above that point, while the maximum has no definite limit and may reach the dangerous height of 107° F. It should be noticed that the highest daily temperature in disease, as in health, occurs in the afternoon, when the temperature of the air in summer is the greatest.

The conditions affecting the temperature of the body other than those due to physiological conditions are very numerous. First and most obvious is the temperature of the surrounding atmosphere. It is a well-established fact that an average temperature of the air of 54° F. is best adapted to the public health, for at that temperature the decomposition of animal and vegetable matter is slight, and normal temperature is most easily maintained. Every degree of temperature above or below that point requires a more or less effort of the heat-regulating power to maintain the proper equilibrium. Even more potent in elevating the bodily temperature is the introduction into the blood, whether by respiration or by direct injection, of putrid fluids and the gases of decomposing matters. If this injection is repeated at short intervals, death will occur with a high temperature. The air of cities contains emanations, in hot weather, from a vast number of sources of animal and vegetable decomposition, and the inhalation of air so vitiated brings in contact with the blood these deleterious products in a highly divided state which cause a fatal elevation of temperature in the young, old, and enfeebled. The same effect is produced by the air in close and heated places, as in tenement houses, workshops, schoolhouses, hospital wards, and other rooms where many persons congregate for hours. Air thus charged with poisonous gases becomes more dangerous if the temperature of the place is raised, as happens almost daily in the summer months in cities. [Pg 439]

From the preceding facts we may conclude that, as long as the body continues in health, the "heat-regulating power," which constantly tends to preserve an equilibrium of temperature, is capable of resisting the ordinary agencies that, operating externally or internally, exaggerate the heat-producing conditions, and thus destroy the individual. But if the person is suffering from a disease which weakens the "heat-regulating power" these deleterious agencies, which the healthy person may resist, will readily overpower the already quite exhausted heat-regulating forces, and he perishes by combustion. It is very evident that in an organism having complicated functions, like that of man, and subject to such a multitude of adverse influences, the balance between health and disease must be very nicely adjusted. Too great an elevation or too great a depression of temperature may destroy the "heat-regulating power," and disease or death will be the consequence. Or this "heat-regulating power" may be weakened or destroyed by causes generated within the body, or received from without, and the heat-producing agencies are then under influences which may prove to be powerfully destructive forces.

It will not now be difficult to understand in what manner high temperature affects the public health of large cities. Evidently in the *direct* action of heat upon the human body we have the most powerful agency in the production of our great summer mortality. While sunstroke represents the maximum direct effect of solar heat upon the human subject, the large increase of deaths from wasting chronic diseases and diarrhœal affections, of children under one year of age and persons upward of seventy years of age, shows the terrible effects of the prevailing intense heat of summer upon all who are debilitated by disease or age and thereby have their "heat-regulating power" diminished. The fact has been established by repeated experiment that when solar or artificial heat is continually applied to the animal the temperature of its body will gradually rise until all of the compensating or heat-regulating agencies fail to preserve the equilibrium, and the temperature reaches a point at which death takes place from actual combustion. In general, a temperature of 107° F. in man would be regarded as indicating an unfavorable termination of any disease. In persons suffering from sunstroke the temperature often ranges from 106° F. to 110° F., the higher temperature appearing just before a fatal termination.

The *indirect* effects of heat appear in the production of poisonous gases which vitiate the air and render it more or less prejudicial to health. Decomposition of all forms of refuse animal and vegetable matter proceeds with far greater rapidity during the summer quarter than during other months of the year. Among the early results of summer heat is the damage to food. Milk retailed through the city, the sole or chief diet of thousands of hand-fed infants, undergoes such changes as to render it not only less nutritious but also hurtful to the digestive organs. The vegetables and fruits in the markets rapidly deteriorate and become unfit for food. Meats and fish quickly take on putrefactive changes which render them more or less indigestible. The effect of this increase of temperature upon the refuse and filth of the streets, courts, and alleys, upon the air in close places, in the tenement houses, and upon the tenants themselves is soon perceptible. The foul gases of decomposition fill the atmosphere of the city and render the air of close and unventilated places stifling; while languor, depression, and debility fall upon the population like a widespread epidemic. The physician now recognizes the fact that a new element has entered into the medical constitution of the season. The sickly young, the enfeebled old, those exhausted from wasting diseases, whose native energies were just sufficient to maintain their tenure of life, are the first to succumb to this pressure upon their vital resources. Diarrhœal diseases of every form next appear and assume a fatal intensity, and finally the occurrence of sunstroke (or heat-stroke) determines the maximum effects of heat upon the public health. The sickness records of dispensaries and the mortality records of the Health Department show that a new and most destructive force is now operating, not only in the diseases above mentioned, but in nearly all of the diseases of the period. Fevers, inflammatory diseases, and others of a similar nature run a more rapid course, and are far less amenable to treatment. This is due, in the opinion of eminent medical authority, to the addition of the heat of the air to the heat of the body. Indeed, the only safety is in flight from the city to the country and to cool localities, as the seashore or the mountains. The immediate improvement of those suffering from affections of the city when transferred to the country is often marvelous, and shows conclusively how fatal is the element of heat in its direct and indirect effects upon the residents of the city. [Pg 440]

Let us next consider the causes of high temperature in the city of New York. It is a well-established fact that the temperature of large and densely populated towns is far higher than the surrounding country. This is due to a variety of causes, the chief of which are the absence of vegetation; the drainage and hence the dryness of the soil; the covering of the earth with stone, bricks, and mortar; the aggregation of population to surface area; the massing together of buildings; and the artificial heat of workshops and manufactories. The difference between the [Pg 441] mean temperature of the city at Cooper Institute and at the Arsenal, Central Park, for a single month, illustrates this fact. Another striking difference between the temperature of these two points of observation is that the range is much greater at Central Park than at Cooper Institute, the temperature falling at night more at the former than at the latter place. The effect of vegetation is to lower the temperature at night, while brick and stone retain the heat and prevent any considerable fall of temperature during the twenty-four hours. It may be said of New York that it has all the conditions of increased temperature above given in an intensified form. It has a southern exposure; all of its broad avenues run north and south; the surface is covered with stone, brick, and asphalt; it is destitute of vegetation except in its parks, which have a very limited area compared with the needs of the city; its buildings are irregularly arranged and crowded together so as to give the largest amount of elevation with the least superficial area; ventilation of courts, areas, and living rooms is sacrificed; its ill-constructed and overcrowded tenement houses, especially of certain districts, have the largest population to surface area of any city in the civilized world. To these natural and structural unfavorable sanitary conditions must be added the enormous production of artificial heat in dwellings. When the summer temperature begins to rise the solar heat is constantly added to the artificial heat already existing. The temperature of the whole vast mass of stones, bricks, mortar, and asphalt gradually increases, with no other mitigation or modification than that caused by the inconstant winds and occasional rainstorms. And the evils of high temperature are yearly increasing as the area of brick, stone, and asphalt extends. The records of sunstroke during the past few years is appalling, both on account of the number of cases and their comparative increase. If no adequate remedy is discovered and applied, the day would not seem to be distant when the resident, especially if he is a laborer, will remain in the city and pursue his work during the summer at the constant risk of his life.

Turning now to consider the question of the measures which are best adapted to protect the present and future population of New York from the effects of high summer temperatures, we are met by many suggestions of more or less value. The more important methods proposed are: a large supply of public baths; the daily flushing of the streets with an immense volume of river water; recreation piers; excursions to the seashore; temporary residence in the country, etc. But these are for the most part temporary expedients, applicable to individuals, and are but accessory to some more radical measure which aims to so change the atmospheric conditions that excessive heat can not occur. The real problem to be solved may be thus stated: How can the [Pg 442] temperature of the city of New York be so modified during the summer months as to prevent that extreme degree of heat on which the enormous sickness and death rate of the people depend? Discussing the subject broadly from this standpoint, it becomes at once evident that we must employ those agencies which in the wide field of Nature are designed to mitigate heat and purify the air and thus create permanent climatic conditions favorable for the habitation of man.

It requires but little knowledge of the physical forces which modify the climate of large areas of the earth's surface to recognize the fact that vegetation plays a most important part. And of the different forms of vegetation, trees, as compared with shrubs, plants, vines, and grasses, are undoubtedly the most efficient. This is due to the vast area of surface which their leaves present to the air on a very limited ground space. The sanitary value of trees has hitherto been practically unrecognized by man. With the most ruthless hand he has everywhere and at all times sacrificed this most important factor in the conservation of a healthful and temperate climate. He has found, too late, however, that by this waste of the forests he has by no means improved his own condition. The winters have become colder, the summers hotter; the living springs have ceased to flow perpetually; the fertilizing streams have disappeared; the earth is deeply frozen in winter and parched in summer; and, finally, new and grave diseases have appeared where formerly they were unknown.

It is well understood that the temperature in a forest, a grove, or even a clump of trees, is cooler in summer and warmer in winter than the surrounding country. Man and animals alike seek the shade of groves and trees during the heat of the day, and are greatly refreshed and revived by the cool atmosphere. The difference between the temperature of the air under and among the branches of a single tree, densely leaved, and the surrounding air, on a hot day, is instantly realized by the laborer or traveler who seeks the shade. The thermometer in the sun and shade shows a difference of twenty, thirty, and forty degrees, and in the soil a difference of ten to eleven degrees. The reverse is true in winter. The laborer and traveler exposed to the cold of the open country find in the forest a degree of warmth quite as great as in a building but imperfectly inclosed. Railroad engineers inform us that they have occasion to use far less fuel in passing through forests in winter than in traversing the same distance in the open country. When the ground in the fields is frozen two or three feet deep, its temperature in the forest is found above the freezing point.

Forests and even single trees have, therefore, a marked influence upon the surrounding [Pg 443] atmosphere, especially during the summer, and they evidently tend to equalize temperature, preventing extremes both in summer and winter. Hence they become of immense value as sanitary agencies in preserving equality of climatic conditions.

It is believed by some vegetable physiologists that trees exert this power through their own inherent warmth, which always remains at a fixed standard both in summer and winter. "Observation shows," says Meguscher,[2] "that the wood of a living tree maintains a temperature of from 54° to 56° F., when the temperature stands from 37° to 47° F. above zero, and that the internal warmth does not rise and fall in proportion to that of the atmosphere. So long as the latter is below 67° F., that of the tree is always highest; but, if the temperature of the air rises to 67° F., that of the vegetable growth is the lowest." Since, then, trees maintain at all seasons a constant mean temperature of 54° F., it is easy to see why the air in contact with the forest must be warmer in winter and cooler in summer than in situations where it is deprived of that influence.[3]

Again, the shade of trees protects the earth from the direct rays of the sun, and prevents solar irradiation from the earth. This effect is of immense importance in cities where the paved streets become excessively heated, and radiation creates one of the most dangerous sources of heat. Whoever has walked in the streets of New York, on a hot summer's day, protected from the direct rays of a midday sun by his umbrella, has found the reflected heat of the pavement intolerable. If for a moment he passed into the dense shade of a tree, he at once experienced a marked sense of relief. This relief is not due so much to the shade as to the cooling effect of the vaporization from the leaves of the tree.

Trees also have a cutaneous transpiration by their leaves. And although they absorb largely the vapor of the surrounding air, and also the water of the soil, they nevertheless exhale constantly large volumes into the air. This vaporization of liquids is a frigorific or cooling process, and when most rapid the frigorific effect reaches its maximum. The amount of fluid exhaled by vegetation has been, at various times, estimated with more or less accuracy. Hales[4] states that a sunflower, with a surface of 5.616 square inches, throws off at the rate of twenty to twenty-four ounces avoirdupois every twelve hours; a vine, with twelve square feet of foliage, exhales at the rate of five or six ounces daily. Bishop Watson, in his experiments on grasses, estimated that an [Pg 444]
acre of grass emits into the atmosphere 6.400 quarts of water in twenty-four hours.

It is evident, therefore, that vegetation tends powerfully to cool the atmosphere during a summer day, and this effect increases in proportion to the increase of the temperature. The influence of trees heavily leaved, in a district where there is no other vegetation, in moderating and equalizing the temperature, can not be overestimated. The amount of superficial surface exposed by the foliage of a single tree is immense. For example, "the Washington elm, of Cambridge, Mass., a tree of moderate size, was estimated several years since to produce a crop of seven million leaves, exposing a surface of two hundred thousand square feet, or about five acres of foliage."

Trees regulate the humidity of the air by the process of absorption and transpiration. They absorb the moisture contained in the air, and again return to the air, in the form of vapor, the water which they have absorbed from the earth and the air. The flow of sap in trees for the most part ceases at night, the stimulus of light and heat being necessary to the function of absorption and evaporation. During the heated portions of the day, therefore, when there is the most need of agencies to equalize both temperature and humidity, trees perform their peculiar functions most actively. Moisture is rapidly absorbed from the air by the leaves, and from the earth by the roots, and is again all returned to the air and earth by transpiration or exudation. The effect of this process upon temperature and humidity is thus stated by Marsh: "The evaporation of the juices of the plant by whatever process effected, takes up atmospheric heat and produces refrigeration. This effect is not less real, though much less sensible in the forest than in meadow and pasture land, and it can not be doubted that the local temperature is considerably affected by it. But the evaporation that cools the air diffuses through it, at the same time, a medium which powerfully resists the escape of heat from the earth by radiation. Visible vapor or clouds, it is well known, prevent frosts by obstructing radiation, or rather by reflecting back again the heat radiated by the earth, just as any mechanical screen would do. On the other hand, clouds intercept the rays of the sun also, and hinder its heat from reaching the earth." Again, he says, upon the whole, their general effect "seems to be to mitigate extremes of atmospheric heat and cold, moisture and drought. They serve as equalizers of temperature and humidity."

Again, let us notice the effects of trees upon malarial emanations. The power of trees, when in leaf, to render harmless the poisonous emanations from the earth has long been an established fact. Man may live in close proximity to marshes from which arise the most dangerous malaria [Pg 445]
with the utmost impunity, provided a grove intervene between his home and the marsh. This function of trees was known to the Romans, who enacted laws requiring the planting of trees in places made uninhabitable by the diffusion of malaria, and placed groves serving such purposes under the protection of some divinity to insure their protection. It is a rule of the British army in India to select an encampment having a grove between the camp and any low, wet soil.

Finally, trees purify the atmosphere. The process of vegetable nutrition consists in the appropriation by the plant or tree of carbon. This element it receives from the air in the form principally of carbonic acid, and in the process of digestion the oxygen is liberated and again restored to the air, while the carbon becomes fixed as an element of the woody fiber. Man and animals, on the contrary, require oxygen for their nutrition, and the supply is in the air they breathe. Carbon is a waste product of the animal system, and, uniting with the oxygen, is expired as carbonic acid, a powerful animal poison. A slight increase of the normal quantity of carbonic acid in the air renders it poisonous to man, and continued respiration of such air, or a considerable increase of the carbonic acid, will prove fatal. The animal and vegetable world, therefore, complement each other, and the one furnishes the conditions and forces by which the other maintains life and health. "Plants," says Schacht, "imbibe from the air carbonic acid and other gaseous or volatile products exhaled by animals, developed by the natural phenomena of decomposition. On the other hand, the vegetable pours into the atmosphere oxygen, which is taken up by animals and appropriated by them. The tree, by means of its leaves and its young herbaceous twigs, presents a considerable surface for absorption and evaporation; it abstracts the carbon of carbonic acid, and solidifies it in wood fecula, and a multitude of other compounds. The result is that a forest withdraws from the air, by its great absorbent surface, much more gas than meadows or cultivated fields, and exhales proportionally a considerably greater quantity of oxygen. The influence of the forests on the chemical composition of the atmosphere is, in a word, of the highest importance."[5]

In large cities, where animal and vegetable decomposition goes on rapidly during the summer, the atmosphere is, as already stated, at times saturated with deleterious gases. At the period of the day when malaria and mephitic gases are emitted in the greatest quantity and activity, this function of absorption by vegetation is most active and powerful. Carbonic acid, ammoniacal compounds, and other gases, products of putrefaction, so actively poisonous to man, are [Pg 446] absorbed, and in the process of vegetable digestion the deleterious portion is separated and appropriated by the plant, while oxygen, the element essential to animal life, is returned to the air. Trees, therefore, in cities, are of immense value, owing to their power to destroy or neutralize malaria, and to absorb the poisonous elements of gaseous compounds, while they render the air more respirable by emitting oxygen.

The conclusion from the foregoing facts is inevitable that one of the great and pressing sanitary wants of New York city is an ample supply of trees. It is, in effect, destitute of trees; for the unsightly shrubs which are planted by citizens are, in no proper sense, adequate to the purpose which we contemplate. Its long avenues, running north and south, without a shade tree, and exposed to the full effect of the sun, are all but impassable at noonday in the summer months. The pedestrian who ventures out at such an hour finds no protection from an umbrella, on account of the radiation of the intense heat from the paved surface. Animals and man alike suffer from exposure in the glowing heat. Nothing mitigates its intensity but the winds or an occasional rainstorm. And when evening comes on, the cooling of the atmosphere produced by vegetation does not occur, and unless partially relieved by favoring winds or a shower the heat continues, but little abated, and the atmosphere remains charged with noxious and irrespirable gases. It is evident that shade trees, of proper kinds, and suitably arranged, supply the conditions necessary to counteract the evils of excessive heat. They protect the paved streets and the buildings largely from the direct rays of the sun; they cool the lower stratum of air by evaporation from their immense surfaces of leaves; they absorb at once the malarious emanations and gases of decomposition, and abstract their poisonous properties for their own consumption; they withdraw from the air the carbonic acid thrown off from the animal system as a poison, and decomposing it, appropriate the element dangerous to man, and give back to the atmosphere the element essential to his health and even life.[6]

And we may add that cultivated shade trees in New York would be an artistic and attractive feature of the streets. Every citizen enjoys trees, as is evident from the efforts made to cultivate them throughout the city.

It is frequently alleged that trees can not be successfully cultivated in cities on account of the gases in the soil. There are ample proofs to the contrary. The city of Paris strikingly illustrates the possibility of cultivating a large variety of trees in the streets and public places of large cities [Pg 447] when the planting and cultivation is placed under competent authority. In our own country the cities of New Haven and Washington are examples of the successful cultivation of trees to an extent sufficient to greatly modify the summer temperature. Authorities on landscape gardening and forestry sustain the view that under proper supervision by competent and skilled persons a great variety of trees, shrubs, plants, and vines can be cultivated in the streets and public places of this city. Mr. Frederick Law Olmstead, to whom the city is so much indebted for his intelligent supervision of Central Park in its early period, warmly supported a movement to cultivate trees, shrubs, plants, and vines in the streets of New York. Dr. J.T. Rothrock, the very able and experienced Commissioner of Forestry of Pennsylvania, under date of October 10, 1898, speaking of the proposed plan of securing the cultivating trees in the streets of this city, remarks: "I think it an excellent measure, and I am sure that during the torrid season the more tree shade you have the fewer will be your cases of heat exhaustion. It is idle to say, as is often said in this country, that trees can not be made to grow in our cities. Under existing conditions the wonder is, not that trees look unhealthy in most cities, but that any of them manage to live at all. It is perfectly well known that the city of Paris has thousands of trees growing vigorously under such surroundings as the American gardener would think impossible. Two things are necessary to success—viz., first, the kinds of trees to endure city life must be found; and, second, select from among them such as are adapted by their size and shape to each special place."

Mr. Gifford Pinchot, of the Division of Forestry, Department of Agriculture, Washington, writes under date of December 2, 1898: "Street trees are successfully planted in great numbers in all of the most beautiful cities of the world. Washington and Paris are conspicuous examples. That such trees succeed is largely due to the great care taken in setting them out. The attractiveness of cities has come to be reckoned among their business advantages, and nothing adds to it more than well-selected, well-planted, and well-cared-for trees. On the score of public health trees in the streets of cities are equally desirable. They become objectionable only when badly selected and badly maintained."

In a recent paper on Tree Planting in the Streets of Washington, Mr. W.P. Richards, surveyor of the District of Columbia, remarks that, under the plan adopted, "tree planting has never been at an experimental stage" in that city. "Washington was a city of young trees during the seventies, and in the spring of 1875 more than six thousand trees were planted, consisting of silver maples, [Pg 448] Norway maples, American elms, American and European lindens, sugar maples, tulip trees, American white ash, scarlet maples, various poplars, and ash-leaved maples.... A careful count was made of the trees in 1887, and by comparing this with the number of trees since planted and those removed, there is found to be more than seventy-eight thousand trees, which if placed thirty feet apart would line both sides of a boulevard between Washington and New York. These consist of more than thirty varieties." Mr. Richards adds: "The planting and care of trees in Washington grows from year to year, and the future will probably demand more skill and judgment than in years past. About twenty thousand dollars is spent annually, most of it in the care of old trees. From one to three thousand young trees are planted during the spring and fall of each year. The nursery has several thousand of the best varieties ready for planting."

The opinions of these authorities and the success of the work in Washington, now extending over a quarter of a century, determine beyond all question the feasibility and practicability of successfully cultivating trees in the streets of cities. And if any one doubts the power of trees cultivated in the streets to change the temperature of a city let him calculate the amount of foliage which the seventy-eight thousand trees, when full-grown, will furnish the city of Washington, taking as his basis the fact that a single tree, the Washington elm, at Cambridge, Massachusetts, when in full leafage, equals five acres of foliage, and that one acre of grass emits into the atmosphere 6.400 quarts of water in twenty-four hours, a powerfully cooling process.

We have, finally, to consider through what agency the proposed cultivation of trees in the city of New York can be accomplished most rapidly and successfully. Three methods may be suggested, viz.: 1. Encourage citizens each to plant and cultivate trees on his own premises. 2. Organize voluntary "tree-planting associations," which shall aid citizens or undertake to do the work at a minimum cost. 3. Place the work under the entire supervision and jurisdiction of public authority. The first method has been on trial from the foundation of the city, and its results are a few stunted apologies for trees which are useless for sanitary purposes and unsightly for ornamentation. The average citizen is entirely incompetent either to select the proper tree or to cultivate it when planted. Tree-planting associations have proved useful agencies in exciting a popular interest in the subject, and in aiding citizens in the selection of suitable trees and in cultivating them. The Tree-Planting and Fountain Society of Brooklyn, under the very able [Pg 449] management of its accomplished secretary, Prof. Lewis Collins, is a model organization of the kind, and has accomplished a vast amount of good in this field in that city. But it may well be questioned if we have not reached a period of sanitary reform in cities when a work of the kind we contemplate in New York should not be undertaken by the strong arm of the city government, as a matter of public policy, and carried steadily forward to its completion. The growth of the greater city is far too rapid in every direction to await the slow movements of the people under the pressure of voluntary organizations. The best work can be done in those outlying districts where the streets are as yet but sparsely built upon, and the soil has been undisturbed. Again, it is of the utmost importance that a work of this kind, which will largely prove one of city ornamentation, should be under the exclusive direction of a skilled central authority having ample power and means to harmonize every feature of the work from the center of the city to its remotest limits. Finally, the successful cultivation of trees and other vegetation in our streets can be successfully carried on only by experts in the art of tree culture, who devote their entire time and energies to these duties, and are sustained by the power of the city government. Mr. Frederick Law Olmstead remarks, "Not one in a hundred of all that may have been planted in the streets of our American cities in the last fifty years has had such treatment that its species would come to be if properly planted and cared for." Mr. Richards, in the paper referred to on Tree Planting in the Streets of Washington, makes the following statement: "The selection, planting, and care of all trees in the streets of Washington are under the direction of the District authorities; individual preferences and private enterprises are not allowed to regulate this improvement, as is generally done in other cities. Moreover, the city has its own nursery, where seeds planted from its own trees grow and supply all the needed varieties."

It is apparent that to accomplish such a work as we propose the undertaking must be placed under the jurisdiction of a department of the city government, skilled in the performance of such duties, fully equipped with all needful appliances, and clothed with ample power and supplied with the financial resources necessary to overcome every obstacle. Fortunately, we have in our Department of Parks an organized branch of the city administration endowed with every qualification for the performance of these duties. The charter provides as follows: "It shall be the duty of each commissioner ... to maintain the beauty and utility of all such parks, squares, and public places as are situated within his jurisdiction, and to institute and execute all measures for the improvement thereof for ornamental purposes and for the beneficial uses of the people of the [Pg 450] city, ... and he shall have power to plant trees and to construct, erect, and establish seats, drinking fountains, statues, and works of art, when he may deem it tasteful or appropriate so to do." At the head of this service is "a landscape architect, skilled and expert, whose assent shall be requisite to all plans and works or changes thereof respecting the conformation, development, or ornamentation of any of the parks, squares, or public places of the city, to the end that the same may be uniform and symmetrical at all times."

The conclusion seems inevitable that public policy requires that, in the interests of the health of the people and the comfort and well-being of that large class of the poor who can not escape the summer heat by leaving the city, the jurisdiction of the Park Department should be extended to all trees, shrubs, plants, and vines now and hereafter planted and growing in the streets of New York, and that said department should be required to plant such additional trees, shrubs, etc., as it may from time to time deem necessary and expedient for the purpose of carrying out the intent and purpose of such act which should be declared to be to improve the public health, to render the city comfortable to its summer residents, and for ornamentation.

"He who plants a tree, he plants love;
Tents of coolness, spreading out above
Wayfarers, he may not live to see.
Gifts that grow are best,
Hands that bless are blest.
Plant. Life does the rest."

MIVART'S GROUNDWORK OF SCIENCE.[7]

By Prof. WILLIAM KEITH BROOKS.

If books like this by Professor Mivart, who holds that "the groundwork of science must be sought in the human mind," help to teach that the greatest service of science to mankind is not "practical," but intellectual, they are worthy the consideration of the thoughtful, even if this consideration should lead some of the thoughtful to distrust Mivart's groundwork, or to doubt whether it is firm enough for any superstructure.

Many, no doubt, think the desire to know a sufficient groundwork for science, believing that they wish to know in order that they may rightly order their lives; but the school to which Mivart belongs tells them all this is mere vulgar ignorance, since the groundwork of science is, and must be, something known, rather than a humble wish to know. [Pg 451]

According to Mivart, the groundwork of science consists of truths which can not be obtained by reasoning, and can not depend for their certainty on any experiments or observations alone, since whatever truths depend upon reasoning can not be ultimate, but must be posterior to, and depend upon, the principles, observations, or experiments which show that it is indeed true, and upon which its acceptance thus depends. The groundwork of science must therefore be composed, he says, of truths which are self-evident; and he assures us that, if this were not the case, natural knowledge would be mere "mental paralysis and self-stultification."

He would tell the wayfarer who, having been lost among the mountains, comes at last upon a broad highway winding around the foothills and stretching down over the plain to the horizon, that an attempt to go anywhere upon this road is "mere paralysis," unless he knows where it begins and where it ends. He would have told the ancient dwellers upon the shores of the Nile that their belief that they owed to the river their agriculture, their commerce, their art and science, and all their civilization, was mere self-stultification, because they knew nothing of its sources in the central table-land.

May not one believe, with Mivart, that the scientific knowledge which arises in the mind by means of the senses through contact with the world of Nature, thus arises by virtue of our innate reason, and yet find good ground for asking whether physical science may not have something useful and important to tell us about the mechanism and history of this innate reason itself? Is proof that our reason is innate, or born with us, proof that it is ultimate or necessary or beyond the reach of improvement and development by the application of natural knowledge? May not this reason itself prove, perhaps, to be a mechanical *phenomenon* of matter and motion, and a part of the discoverable order of physical causation; and may not science some time tell us how it became innate, and what it is worth?

Questions of this sort are easy to ask but hard to answer; for many hold our only way to reach an answer to be *to find out* by scientific research and discovery. While this method may be too slow for *a priori* philosophers, may it not be wise for those who, being no philosophers, know of no short cut to natural knowledge, to admit that, while they would like to know more, they have not yet learned all there is to learn? If this suspension of judgment is indeed self-stultification, the case of many students is hard, though they may not really find themselves so helpless as they are told that they must be; for he who is told by the learned faculty that he is paralyzed need not be greatly troubled if he finds his powers for work as much at his command as they were before. [Pg 452]

The modern student has heard so many versions of the story of the two-faced shield that he is much disposed to suspect that many of the questions which have so long divided "philosophers" may be only new illustrations of the old fable, and he asks whether there need be any real antagonism between those who attribute knowledge to experience and those who attribute it to our innate reason.

There are men of science who, seeing no good reason to challenge Plato's belief that experience, creating nothing, only calls forth the "ideas" which were already dormant or latent in the mind, do nevertheless find reason to ask whether exhaustive knowledge of our physical history may not some time show how these dormant "ideas" came to be what they are. They ask whether errors may not be judgments which lead us into danger and tend to our physical destruction, and whether it may not be because a judgment has, in the long run, proved preservative in the struggle for existence that we call it true. May not, for example, the difference between the error that the stick half in water is bent and the truth that the stick in air is straight, some time prove to be that the savage who has rectified his judgment has speared his fish, while he who has not has lost his dinner?

So long as we can ask such questions as this, how can we be sure that because a judgment is no more than might have been expected from us, as Nature has made us, at our present intellectual level, it is either necessary or ultimate or universal? Things that are innate or natural are not always necessary or universal, for while reason is natural to the mind of man, some men are unreasonable, and a few have been even known to be illogical.

It therefore seems clear that another view of the groundwork of science than that set forth by Professor Mivart is possible, for many believe that this groundwork is to be found in our desire to know what we do not yet know, rather than in things known; and they believe they wish to know in order that they may learn to distinguish truth from error, and walk with sure feet where the ignorant grope and stumble.

Many books are profitable and instructive even if they fail to convince; and the question which a prospective student of Mivart's book is likely to ask is whether it is consistent with itself; for if the author has not so far made himself master of his subject as to state his case without palpable contradiction, no one will expect much help from him. It is a remark of Aristotle, in the Introduction to the Parts of Animals, that while one may need special training to tell whether an author has proved his point, all may judge whether he is consistent with himself, and the attempt [Pg 453]
to learn whether Mivart's book is consistent may not greatly tax our minds.

He tells us that many men of science are "idealists"; and he says that idealism, being mere self-stultifying skepticism, must be refuted and demolished before we can begin our search for the groundwork of science or be sure that we know anything. It would have surprised Berkeley not a little to be told that his notions are the very essence of skepticism, for the good bishop tells us again and again that his only motive in writing is to make an end of idle skepticism, once for all, that they who are no philosophers, but simple, honest folks, may come by their own and live at ease.

There is little ease, and less justice, even at this late day, for the man of science who insists that he is neither an idealist nor a materialist nor a monist, but a naturalist; and that it will be time enough to have an opinion as to the relation between mind and matter when we find out; but many will, no doubt, be pleased to hear that the crime of which they are now suspected is no longer "materialism," but "idealism," for the public attaches no odium to the idealist, whatever may be Professor Mivart's verdict. Still all must feel an interest in the exposure of the weakness of idealism, since we have been told, by many shrewd thinkers, that Berkeley's statement of the case, while inconclusive, is unanswerable; although they hold that it is lack of experimental evidence which stands in the way of either its acceptance or its refutation.

Mivart begins his treatment of idealism by a simple and satisfactory summary, pages 36-38, of Berkeley's Principles, but he forgets it on the next page, for it is no exaggeration to assert that the "idealism" which he refutes is a mere parody on that which he has just given his readers, and something that no sane man would dream of holding.

For example, he admits, on page 38, that nothing "can be more absurd than the criticism of those persons who say that idealists, to be consistent, ought to run up against lamp-posts, fall into ditches, and commit other like absurdities." On page 47 he undertakes to show, "by the natural spontaneous judgment of mankind," that external material bodies exist "of themselves, and have a substantial reality in addition to that of the qualities we perceive; because the spontaneous judgment of mankind accords with what even animals learn through their senses. A wide river is an objective obstacle to the progress of a man's dog, as well as to that of the dog's owner."

One who compares the extract from page 38 with this from page 47 can, so far as I can see, reconcile them only by one of these hypotheses: 1, that Mivart holds a wide river to afford proof of reality which is not afforded by a ditch; or, 2, that the dog which does not run against lamp- [Pg 454]
posts affords evidence of the reality of Nature which is not afforded by a man in the same circumstances; or, 3, that "nothing can be more absurd than the criticism of these persons" who reason like Professor Mivart.

While sometimes right and sometimes wrong, like the rest of us, the apostle of tar water was no fool, although the groundwork of Mivart's science, in the book before us, is the assertion that idealists idiotically deny everything which they have not perceived, and hold that the external world has no existence.

It is hard to see how words could be clearer than those in which Berkeley repudiates all nonsense of this sort. "I do not argue," says he, "against the existence of any one thing that we apprehend, *either by sense or by reflection*. That the things I see with my eyes and touch with my hands do exist, really exist, I make not the least question. I am of a vulgar cast, simple enough to believe my own senses, and to take things as I find them. To be plain, it is my opinion that the real things are the very things that I see and feel, and perceive by my senses. I can not for my life help thinking that snow is white and fire hot. And as I am no skeptic with regard to the nature of things, so neither am I as to their existence. That a thing should be really perceived by my senses, and at the same time not really exist, is to me a plain contradiction. Wood, stone, fire, water, flesh, iron, and the like things, which I name and discourse of, are things I know. Away, then, with all that skepticism, all those ridiculous philosophical doubts! I might as well doubt of my own being as of the being of those things I actually see and feel."

Mivart lays great stress upon the opinion of men in general as a refutation of idealism; and as Berkeley also says he is content to appeal to the common sense of the world, it may be well to ask what the verdict of "plain, untutored men" is, even if we doubt whether such a jury is the highest tribunal.

"Ask the gardener," says Berkeley, "why he thinks yonder cherry tree exists in the garden, and he shall tell you, because he sees it and feels it."

Mivart holds it one thing to see, and quite another matter to know that we see, for he says that while we see and feel the "qualities" of things by those "lower faculties" which we share with the "brutes," we perceive the "substance" in which these qualities inhere, by certain "higher faculties," which, whether represented in the brutes by latent potencies or not, have been "given" to man in their completeness, and not slowly and gradually built up from low and simple beginnings in the brutes.

The question we are to ask the gardener is, therefore, something to this effect: Whether he thinks the cherry tree exists because he sees it and feels it, or because, when he sees it and feels it, he knows that he does so? [Pg 455]

If he weighs his words will he not ask how he can know that he does see it and feel it unless he knows that he does so? I, myself, am no philosopher; but, to my untutored mind, Mivart's distinction between things perceived by *sense*, and things *perceived* by sense, seems a mere verbal difference of accent and emphasis, rather than a fundamental distinction.

As most men use the word, "mind" implies consciousness of that sort which Mivart calls self-consciousness, and while there is no reason why those who choose should not so use the word as to include unconscious or "subconscious" or "conscientious" cerebration, most plain, untutored men prefer to use words as their neighbors do.

If long waiting on Nature has given to the old gardener more shrewdness than we commonly find in those whose pursuits are less leisurely, he may say that, while he knows the tree is there because he has planted it and tended it and watched it grow, it now falls on his eyes day after day, without attracting his notice, unless something about it which calls for his skill *catches* his eye, and *commands* his *attention*.

If we see reason to believe that this difference is a matter of words and definitions, rather than a real difference in kind; if we fail to find any sharp dividing line between unperceived cerebration and "mind," is not this, in itself, enough to lead even Macaulay's schoolboy to ask whether mind may not be a slow and gradual growth from small beginnings, and a co-ordinated whole, to the common function of which all its parts contribute, rather than a "gift" of "lower faculties" and "higher faculties"?

We must ask, however, whether mechanical explanations of mind are in any way antagonistic to the conviction that it is a gift. May not one study the history of the mechanism of mind, and the way this mechanism works, in a spirit of profound and humble gratitude to the Giver of all good gifts?

Is the lamentable prevalence, among plain untutored men, of the notion that mechanical explanations of Nature are inconsistent with belief that all Nature is a gift, to be laid to the charge of the men of science?

Is it not rather the poisonous fruit of the ill-advised attempts of "philosophers" like Professor Mivart to teach that a gift can not be a gift at all unless it is an arbitrary interruption to the law and order of physical Nature?

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THE SCIENCE OF OBSERVATION.

By CHARLES LIVY WHITTLE.

This is an era of observation; in many fields and in divers countries the study of Nature from a strictly scientific standpoint is being prosecuted with results which are rapidly increasing our knowledge of the universe. This modern growth has come about as the natural rebound of the suppressed energy that has been held forcibly under subjugation during the last two thousand years, at a time when the closing echoes of the warfare between the literal interpretation of the Scriptures and science have ceased.

A review of this long battle with the forces of the Catholic and Protestant churches on the one hand, arrayed against a relatively few investigators, scattered through the last ten centuries, on the other hand, shows a record on which none can look without regret. As far as we are able to learn, there was little opposition to the study of science before the collection and translation of the old manuscripts now constituting the Alexandrian version of the Bible and the consequent upbuilding of the Jewish church. The remains of ancient Egyptian civilization show that science prior to that period, as measured by the discoveries in physics and astronomy, had attained no inconsiderable prominence; and had this people endured until the present time, uninfluenced by the strife that for many centuries racked the inhabitants of the eastern hemisphere, we should to-day be far more advanced in our understanding of the universe.

In the more progressive countries, at least, the breaking of the shackles in which the investigating mind had been imprisoned for so long has led not only to a greater number of scientific workers, but also to an increase in the fields of observation. The methods of investigation have likewise undergone a transformation. In place of deductive reasoning, even as late as a few decades in the past, conclusions and generalizations are now founded on lines of thought more largely inductive. Men of middle age are able to recall the time when even our leading institutions of learning required instruction in several branches of science to be given by one teacher. It was possible twenty-five years ago for a man of great ability to master the essentials of the leading sciences and to teach them, but under the present stimulus for investigation no one can hope to excel in more than one subject. It has thus come about that in place of the many-sided teacher of science we now have in our larger universities specialists in every subject. As the work of research progresses, the specialist—for example, in geology—is compelled by the increased scope of the information on his subject to select one branch of [Pg 457] geology of which he shall be master. The chair of geology is now split up into economic, glacial, and mining geology, paleontology, etc., and specialists are required in each division. This breaking up is true of most other sciences. In this labyrinth of specialized subjects, and the maze of technical terms rendered necessary thereby, the people as a whole can only grope in darkness; but out of this bewildering condition of affairs, from the mass of facts collected, and the resulting generalizations and theories, there may be culled the kernel of one important principle by means of which these facts are ascertained and the generalizations made. The growth of science and its ever-ramifying divisions, and the gradual establishment of new methods of investigation, have brought forth what may be termed the science of observation; and it is through an application of the above principle that the people may be taught correctly to interpret Nature, and, by their new habit of thought, to free the brain from the tangle of superstition which is still present with most of us.

A knowledge of how to observe natural phenomena and to draw correct inferences therefrom has been the product of slow growth, while through long custom, in matters closely pertaining to our daily life, there has been observation on strictly scientific principles for centuries. Stated succinctly, natural phenomena are due to causes, one or more, simple or complex. These causes are the laws of the universe, and to arrive at an understanding of them we must free our minds of any bias and study phenomena experimentally in the laboratory, or in our daily contact with Nature. In this way a mass of facts will be gathered by the systematic observer which will be found to fall into natural groups, and by inductive reasoning the laws governing each group may be learned. It is not possible for mankind as a whole to investigate in this exhaustive manner; but it is important that the method of arriving at the laws of Nature be understood. Many and, in fact, most phenomena met with in some of the sciences, particularly those having to deal with the earth, are susceptible of correct interpretation without attempting broad generalizations, if the principles of scientific observation are brought to bear upon their solution, and it is our purpose to show by practical examples drawn from Nature how elementary students may attack and solve some of the simple problems met with on every side. It is proposed to use for illustration simple phenomena pertaining to the earth, drawn from geology and its newly constituted sister science, physical geography. These two sciences perhaps afford the greatest range of phenomena, which are accessible to every one, in whatsoever part of the earth he may reside. No part of the land surface is wanting in problems which demand explanation, and which may be attacked from the [Pg 458] standpoint of the geologist or physical geographer, or both. [Pg 459]

One of the most pronounced departures taking place in preparatory-school education at the present time is to be found in the prominence given to these subjects, not only in the schoolroom, but by practical experience in the laboratory of Nature, among the hills and mountains, as well. The object of this departure is twofold: the first and most important is to train the young early to observe phenomena and to interpret them; the second, in a narrower sense, is purely educational. The one inculcates a habit of thought that will be of inestimable advantage in pursuing future study; the other, without taking into consideration the element of mental training, constitutes instruction in concrete things that are matters of general education.

Before the student in the introductory schools is brought in contact with problems in the field, it is essential that he receive text-book or oral instruction in some of the geological processes giving rise to the phenomena to be studied later out of doors. In practical teaching the student is taken on excursions into the region not far removed from the school. At first some simple geological facts are shown him, often on a very small scale, but embodying principles which, when understood, lead to a ready interpretation of larger problems. Step by step the first principles are amplified by a larger and more varied class of examples, until the student is able logically to apply the reasoning in explanation of simple problems to the solution of the greater problems in physical geography and geology. In the absence of such excursions, I shall introduce a series of photographs carefully arranged to lead the reader along the same line of reasoning up to similar broad conclusions—a method which, if not so satisfactory and instructive, will at least have an educative value.

Fig. 1.—Quarry showing Fresh and Weathered Rocks.

Our first excursion will be to a locality where an open cut has been made for the purpose of carrying on quarrying operations. The accompanying photograph has been so taken as to include both the top and the bottom of the quarry (Fig. 1). Let us first inspect the rock in the lower part of the quarry. The existence of planes of fracture, or joints, crossing the rock in various directions, dividing it into blocks, early attracts our attention. The stone appears dark-colored, tough, and is seen to be made up of two or three different minerals: one is black, cleaves readily into thin plates of a translucent nature, and we easily recognize it as an iron-bearing mica, or isinglass. Another is white, and cleaves or breaks in two directions, making angles of about ninety degrees; this we know as common feldspar. The third is less easily recognized as pyroxene, another of the many minerals containing iron. Having tested our knowledge of mineralogy, we will look about and see if all the rock exposed is like that at the bottom of the quarry. As we ascend from the point indicated by the lower hammer, we notice that the dark blue rock gradually takes on a rusty hue, and its toughness has become less. Going still higher, the rusty character increases, and along joints the rock is so lacking in coherency as to fall to pieces when struck a light blow with a hammer. The central portions of the blocks, however, after we have removed the outer shell of rusty material, are seen to be like the lower rock. In the middle foreground of the picture there are shown several bowlders derived from above, which are merely these residual cores, and are known as bowlders of disintegration. These are also shown in place near the top of the picture at the extreme left. Near the top of the quarry, at a point marked by the upper hammer, the solid rock gives place to a rusty mass of loose material, traversing which the cracks may still be seen, and in which there are few indications of the solid rock[8] (see Fig. 2). This loose material when carefully examined is found to be made up of exactly the same minerals as the dense rock below, but we notice that the mica and pyroxene are rusty and that the feldspar is stained yellowish brown. The pyroxene in particular is very much changed, and quickly crumbles away in the hand. It is clear that there is every stage between the solid rock and the incoherent powder at the surface of the ground. The joint planes crossing the solid rock below may still be observed traversing the decayed portion, and also many rounded areas of rock, which are seen to be identical with the stone at the bottom of the quarry.[9]

FIG. 2.—DETAILED VIEW OF A PORTION OF QUARRY SHOWING WEATHERED ROCK.

How shall the facts before us be explained? It has been shown that the dense rock and the loose material are the same mineralogically, and grade from one into the other, and it is certainly rational to suppose that the latter is merely a changed form of the first. Some force must have been at work on the solid rock, destroying its coherency and converting it into loose sand. If we inspect the powdered rock, it will become apparent that this change has been brought about mainly by the process of weathering: surface water, with its ever-present acid impurities, has brought about the partial decay of the pyroxene and mica and caused the disintegration of the upper part of the rock. Water has not only attacked the rock from the upper surface, but has penetrated to considerable depths along the joint planes, working inward toward the center of each block until the mass becomes completely disintegrated. This process explains the concentric shells about cores of unaltered rock, each representing original joint blocks, which are seen in the second photograph. All our excursions into the field will show that this is not an isolated case, for wherever a ledge is exposed to our view there will be found a zone of weathered rock, varying in thickness from mere films to many feet.

By this process the greatest part of the materials constituting soils is formed, and the flora and fauna of the earth are rendered possible. Upon such products of decay the food supply of running water manifestly depends in a large measure, as will be pointed out on our next excursion; and were the scope of this article somewhat larger, it would be easy to show that the rock decay seen in our photograph has taken place in a length of time measured by something like ten thousand years. If all rock decayed as easily, and if the rate of decomposition, as determined here, held good for great distances from the surface, mountains two miles in height would become a prey to the force of chemical action in six and a half million years. [Pg 462] We can not, however, give a time equivalent for the destruction of a mountain range, since decay, and consequent disintegration, is only one of the many forces acting to sap the strength of solid rocks and to tear them asunder. The above figures are given merely to make plain that the time necessary to accomplish the leveling of a mountain chain is but a small part of the earth's existence as such, great as this period may seem from the standpoint of human history.

We shall, if possible, time the second excursion immediately after a heavy rain, and we shall select for our objective point a place where the rain water, in its efforts to reach a stream, is forced to run down some steep declivity. Under such circumstances, the carrying power of the water will be very great, and we shall hope to find evidence of its work in transporting the products of rock weathering and other material broken up by the action of frost. A little diligence will soon reward us with the evidence which we seek. A local inequality of the ground, perhaps only a few feet across, is found filled with water—a minute, temporary lake caused by the recent heavy rainfall. Such little water bodies are extremely common, but the accompanying geological phenomena are, notwithstanding, none the less interesting, and the conclusions to be drawn from the evidence thus presented are none the less valuable.

[Pg 463] If we examine the pool critically, it will be noticed that its shore line is cut by a little channel along which the overflow makes its escape. Further investigation will show that at another point along the shore, especially if we are fortunate enough to visit the locality very soon after a rain, there is a small rivulet entering the pool; and also that the entering stream is discolored with mud and carries more or less sand, while the escaping stream is nearly clear, and is free from all traces of coarse, sandy material. It is therefore evident that the sediment brought in by the stream has been left behind in the pool, and of course will be found deposited at its bottom, and it will appear that the only explanation of the inability of the water further to transport its burden is to be found in the fact that water loses nearly all its motion, and therefore its transporting power, on entering a stagnant pool. These are elementary truths, but an amplification of such simple phenomena is often fully capable of accounting for the most stupendous results.

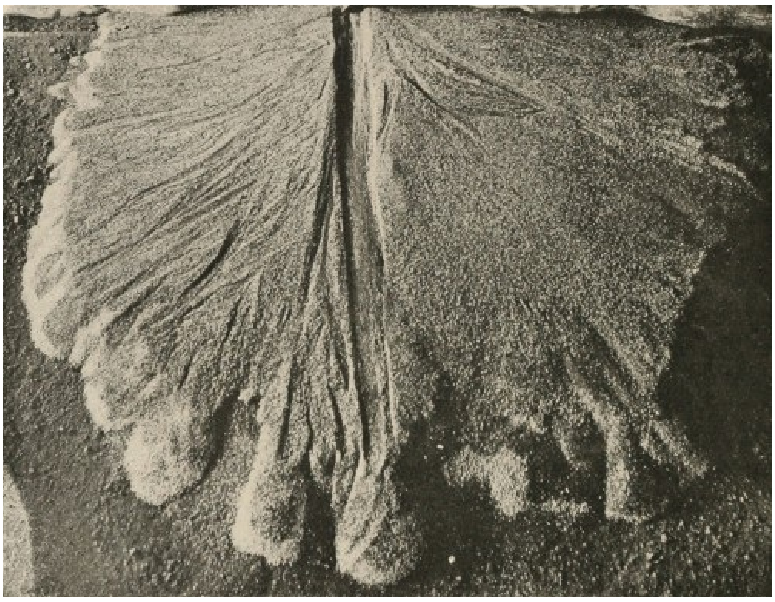


Fig. 3.—Temporary Wet-weather Delta.

Having made these observations, let us look at the form assumed by the sediment when it is forced to fall to the bottom. At the point where the stream enters the pool there is seen an accumulation of material having a nearly level upper surface, presenting a scalloped or lobe-shaped outer margin, upon which the stream may be seen flowing and entering the water at one of the lobes. Other channels, though unoccupied by water, also lead to similar lobes. If we watch closely, we may be able to witness the growth of this body of sand, called a delta, as the falling sediment rapidly increases the size of the lobe; and also to perceive that as soon as the lobe is built out considerably in advance of the main body of sand, it will be easier for the stream to enter the water on one side of the scallop, thus abandoning its old mouth. In this manner the stream moves from one place to another, successively building the little scallops and continually carving new channels for itself. Fig. 3 is a photograph of such a delta, some three feet across, taken after the water had been drained away, and reveals its form in a characteristic manner. As we watch its growth, it will become evident that only the coarsest material transported by the stream goes to make up the delta, and that the clay and finest sand are deposited farther away, where the water is more quiet, or else pass out in the stream draining the pool. Let us look about a little. Not far from our miniature lake there are several others. In some the size of the delta is much larger in proportion to the area of the pool than is the case with the one first studied. We find in some cases that the stream has progressively built its delta completely across the old water surface. Taking a thin piece of board or a large knife, we can easily cut vertically through this sand deposit, thus exposing what is called a geological section. The sand grains of which the deposit is largely composed are seen to be arranged in layers nearly horizontal, and these layers are found to be due to alternations of sediment varying in fineness. This phenomenon is called stratification, and is what we should expect of the action of gravity operating on material of different sizes and densities suspended in a body of water. It has been found inexpedient to attempt to show a photograph of this section, owing to the smallness of the subject, but the same phenomena may be observed on a much larger scale in Fig. 5, which will be described below.

A few rods away the stream that feeds the pool has its origin. The sediment carried by the water and going to build up its delta has its source in part in a neighboring bank made up of material derived from solid rock by weathering, similar to that shown on our first excursion, and partly from older water deposits. Steep channels exist in the disintegrated rock, which represent the material removed by the fast-flowing rain water.

Now what geological phenomena have we observed at this locality? In the first place, it has become clear that running water possesses the power of transporting sediment. In the second place, this sediment has been deposited wherever the velocity of the water has been materially checked. The sediment has been laid down in horizontal layers under the influence of gravity. Furthermore, the material of which the delta is composed has been shown, in part at least, to have been derived from a solid rock such as forms our mountains. In our first excursion we saw that chemical change promoted disintegration; in our second, running water is observed seizing upon these products of decay, transporting them and building them into stratified deposits in the first convenient pool. A level-topped delta is first formed, which may or may not grow to fill the pool in which it is born. Some of the pools have become filled, while the delta as such has disappeared; it has grown into a tiny sand plain.

Let us see if the work performed by these temporary rivulets is typical of running water in general. For this purpose we shall visit a spot where a river enters some considerable body of water such as a lake. Let us inspect the river. Its water is sluggish, discolored by organic matter derived from decaying vegetation, and for some distance up stream from its mouth it meanders slowly across a flat, marshy area or meadow. If we also visit the spot at a time when the river is swollen by heavy rains or melting snows, the presence of this organic matter will be masked by the turbidity of the water; we shall learn that only in the freshet seasons does the water attain sufficient velocity to carry any visible load of sand and clay. The upper end of the lake will be found to be shallow, muddy, and water lilies will have discovered congenial surroundings. At another part of the lake the outflowing water appears clear as crystal; the sediment brought in by [Pg 465] the river has manifestly been deposited in the lake, as was the case in our little pool. The marsh at the upper end, of course, is merely another delta, slow growing in this instance, grass-covered, but as surely encroaching on the water area as in the earlier examples. When an entering stream is normally of great transporting power, owing to steep slopes down which it rushes, the form of its delta is not unlike the one first described.

With the data already gathered, we can not escape from the conclusion that the growth going on at the head of the lake will in time, if present conditions continue to exist, push its way forward until it has occupied the whole water area. The sediment which is now deposited therein will then be transported across the plain, and will be carried along until another body of water is reached. Further search will bring to light the fact that there are plenty of examples showing all stages between the simple delta and the completely filled lake. The innumerable marshes and meadows which characterize the northern part of the United States are fine examples of lakes which have perished in this manner.

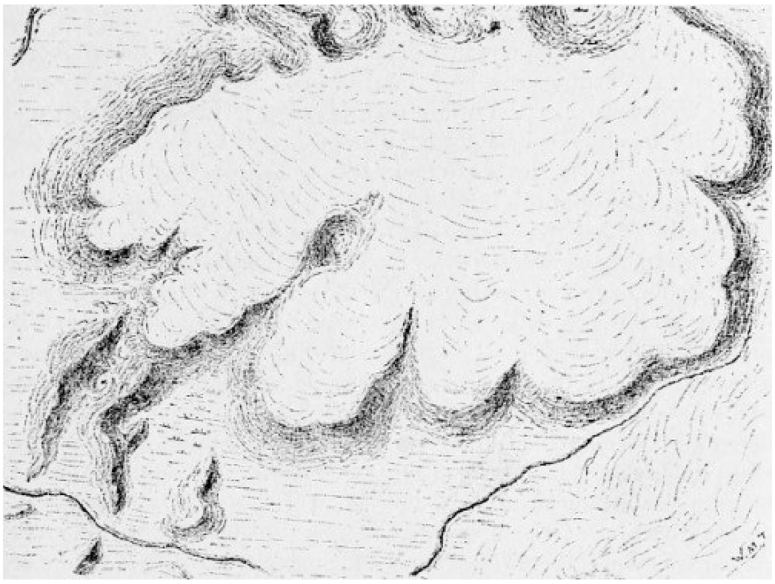


Fig. 4.—A Common Form of Large Delta.

Our next excursion will be made to the locality shown in Fig. 4, which is a sketch of a large delta occurring at a considerable height above the general level of the country, although at the present [Pg 466] time the delta is not in vicinity of water.[10] It will be evident to the reader that it differs in no important particular, excepting size, from our little type specimen formed in a pool. Its level top and frontal lobes are to-day nearly as strongly marked as at the time it was made. The reader will have little difficulty in picturing the original conditions of its formation in some ancient lake. This old lake did not endure until the inflowing streams had filled it to a level plain, but for some reason, which it is unnecessary for us to consider, the water was permitted to escape, leaving the delta perched on the valley side. Such deltas are very common, and we find them in all stages, from simple beginnings, as above, to the completed sand plain.

Fig. 5.—Geological Cross-section of a Delta.

The sand of which our first delta was composed has already been referred to as arranged in horizontal layers. In order to verify our conclusions regarding the origin of this delta, let us seek for an opportunity to observe its internal structure, and to compare it with that observed in the

first example. It may happen that the opportunity does not exist at this immediate locality, but a little way off a similar deposit occurs, and a beautiful section has been uncovered by the vigorous attacks of a steam shovel. This section has already been referred to on page 464, as illustrating the structure of the sand layers making up the tiny delta, as well as water deposits in general, and is reproduced here as Fig. 5. The reader will observe in this picture many familiar features common to railroad excavations. The upper part of the geological section thus exposed is somewhat masked by a downfall of sand and loam, and the lower part is also hidden by the same materials. Along the central part, however, the sand and gravel may be seen arranged in horizontal layers of a varying thickness. A close inspection of the uppermost layers will detect a variation in coarseness among the different strata. Such alternations of layers of coarse and fine material are due to differences in the transporting power of the running water that brought the sand and pebbles to their present resting place; the coarse gravel and pebbles were carried by fast-flowing rivers, and the fine sand by streams of less rapidity and consequently less transporting power. Beds of this character ordinarily correspond closely in time with alternating periods of great rainfall or snow melting and the summer seasons. The pebbles of which the coarse layers are composed, as we should expect, are far from spherical, and the operation of gravity on such bodies, as they fall to the floor of a lake or ocean, is to cause them to arrange themselves with their flat surfaces horizontal and parallel to one another. In the example before [Pg 467]
us this fact is apparent, and affords the basis for another line of reasoning by which all such [Pg 468]
stratified deposits, however great their magnitude, are to be referred to the same source—namely, stream-transported materials derived from a decaying and wasting land surface, laid down in water under the influence of gravity.

We have now arrived at a most important and far-reaching generalization so far as the work performed by running water is concerned, and its action in filling our lakes and ponds; and we have learned by observation on a small scale the means by which such deposits may be recognized. Let us apply these means of recognition to the phenomena shown by our large rivers and the more enduring oceans into which they drain. In the same manner that we have studied the little pool and larger lake, we will look into the work done by the great waterways of our continents, selecting as a type of such streams the mighty Mississippi. Careful measurement has shown that this river annually transports two hundred million tons of sediment mechanically suspended. What becomes of this enormous quantity of sand and clay, equal to a cubic mile in a little over a century, as it is swept into the waters of the Gulf of Mexico? For this purpose we have only to visit the region about its mouth to become acquainted with the almost impotent struggles that have been made by our Government during the last fifty years in an effort to keep the river below New Orleans, in part at least, confined to its present channels; and to study the chart of that portion of the Gulf coast prepared by the United States Coast and Geodetic Survey (see Fig. 6). We have not forgotten the little lobes; their method of growth, and the general form of our first-seen delta, shown in Fig. 3. In viewing the phenomena at the mouth of the Mississippi, it is no longer necessary for our present purposes to make a detailed study, since it will become apparent at once that the river is doing the work on a larger scale typified by the performance of the tiny stream flowing into its temporary pool. In place of the little delta with its still smaller lobes, the Mississippi has deposited at its mouth an enormous delta, thousands of square miles in area, and its bifurcating arms may be seen building out several scallops for miles into the waters of the gulf. For centuries these long lobes have been building in advance of the delta front. The arms gradually become clogged with sediment, a new passage to the ocean is opened on the sides, where deposition will begin at a new point, producing a lobe as before. Situated many miles up the river, it is to-day the great fear of New Orleans that its only navigable arm to the sea will thus be closed to that commerce upon which the life of the city depends.

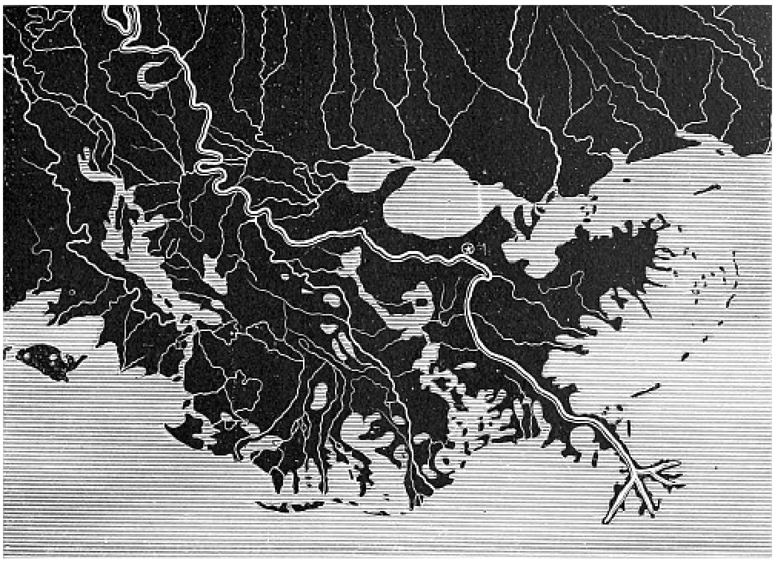


Fig. 6.—The Delta of the Mississippi.

Only a portion of the sediment brought in by the river goes to form its delta; a large part of the finest material, such as clay, is transported by temporary and permanent currents thousands of [Pg 469]
miles away, where it is deposited in the more quiet waters of the ocean. In this manner the Mississippi has been shown to deposit a cubic mile of mechanically transported material in a little

over a century. What shall we say of the effects produced on the continents and oceans by thousands of rivers, each doing its proportionate share of work and acting through millions of years? Two main results must follow, unless interruptions occur: the lower elevations and the magnificent mountain ranges, which rear their lofty heads above the permanent snow line, will be divided into minor peaks; valleys will be carved out; the whole land surface will slowly waste away, at first rapidly, at last slowly, and be transported to the oceans, where it will form great horizontal beds differing in no essential particular, excepting size, from those shown in Fig. 5—great deposits that are merely deltas on a large scale. The geologist, however, finds no evidence to indicate that at any time in the earth's history have these theoretical results taken place. Land masses, of continental dimensions, have not been allowed thus to waste entirely away to a general flatness on account of the interruptions caused by elevation—the bodily lifting of great areas of rock, even out of the ocean floor, to become mountains or plateaus, in some cases higher than any point in this country. If our observations thus far and those yet to be made serve to make this clear, one of the objects of this article will have been accomplished. It is to be hoped [Pg 470] that our observations have made plain the processes of rock disintegration and water transportation; that in the oceans all these materials are eventually deposited in beds horizontally arranged, composed of such products of decay in the condition of sand and mud. We have only to point out the proof that great land masses, composed of water-deposited materials, have been lifted from the ocean to become continents and mountain ranges.

As the ocean deposits slowly accumulate in layers to beds of many thousands of feet in thickness, the lower parts are gradually subjected to greatly increased pressure produced by the overlying beds. During this time waters of a varying temperature, carrying, chemically dissolved, great quantities of lime, silica, and iron oxide, are allowed free circulation through them. These conditions promote chemical change: much silica (the mineral quartz), lesser amounts of carbonate of lime (the mineral calcite), and iron oxide are precipitated about the loose sand grains, firmly cementing them together into a solid rock. A cycle has thus been completed; the dense rocks composing a continent have passed by the process of weathering into incoherent sand and clay, which, when transported to the ocean floor, become again converted into solid rock.

Historical records prove that during the last three thousand years there have taken place many changes in the ocean's level. Old islands have disappeared; new ones have emerged above the surface of the water. Great stretches of seacoast exist at the present time which within the historical period have been covered by the ocean. Even at the present writing we are witnessing the gradual submergence of some parts of the earth and the rising of others; terraces on the northern Atlantic coast may be seen along the hillsides many feet above the present level of the ocean—all of which go to show that the relationship of the land to the water is an unstable one. These are the evidences of continental growth and depressions from the historical standpoint, and the validity of the data upon which the belief is founded can not be shaken. The evidence from the geological side is overwhelming, but before we speak of this it will be well once more to say a word as to the causes of continental uplift.

From an original fluid globe possessing a high temperature, the earth has now cooled down to a degree sufficiently low to permit the formation of a thick rock crust. Underneath this crust an approach to the old surface temperatures is still maintained, and the existence of a certain degree of fluidity is demonstrated to us from time to time by the phenomenon of volcanism. Successive zones of cooling took place. The outer part could only conform to a shrinking interior by wrinkling, folding, or bodily lifting considerable areas above the general level. An adjustment of strains thus set up would take place either with or without folding of the strata. These initial [Pg 471] wrinkles gave rise to our first mountains, and the continuation of these conditions at the present time is as surely nourishing mountain growth as at any time in the past. In this way the fluctuations of the ocean's level, above referred to, alone are to be explained, and such form but temporary rises and falls in the history of a continent.

Fig. 7.—Mountain showing Rock Folding.

The rate at which an ocean bed is raised to form a mountain range is, no doubt, a variable one; always slow, often interrupted, but seldom or never violent. During this time the strata usually undergo crushing and folding; stretching takes place, and displacements of the rocks, or faulting, are not uncommon. As an example of the wrinkling that the strata may suffer under these conditions, the reader is referred to the beautiful symmetrical fold shown on the side of a mountain in the Appalachians (Fig. 7). Similar folding is the rule, but often immense areas are raised to great heights above the ocean without disturbing the horizontal position of the beds (see Fig. 8). Coincident with the emergence of the rocks from beneath the water, there begin the attacks of the forces operating to destroy them. Hand in hand there go on growth and destruction. The two may keep an even pace; either may obtain the mastery. In the one case, lack of considerable elevation and flatness result; in the other, great altitudes may be attained. The rivers may cut their valleys downward as fast as the land rises, or the down-cutting may be relatively slower. In any case, after a given land mass has attained its greatest height above the sea, the larger rivers soon cut their channels down as far as river cutting is possible—namely, to within a few feet of sea level. With relatively rapid elevation, soft rocks, and large rivers, the resultant valley takes the form of a cañon, examples of which are found along the courses of the Colorado and the Yellowstone Rivers (see Fig. 8).[11] Valleys of this nature soon lose their steep sides by the action of weathering and all that this implies, and pass into a more open state, like that shown in Fig. 9. [Pg 472]

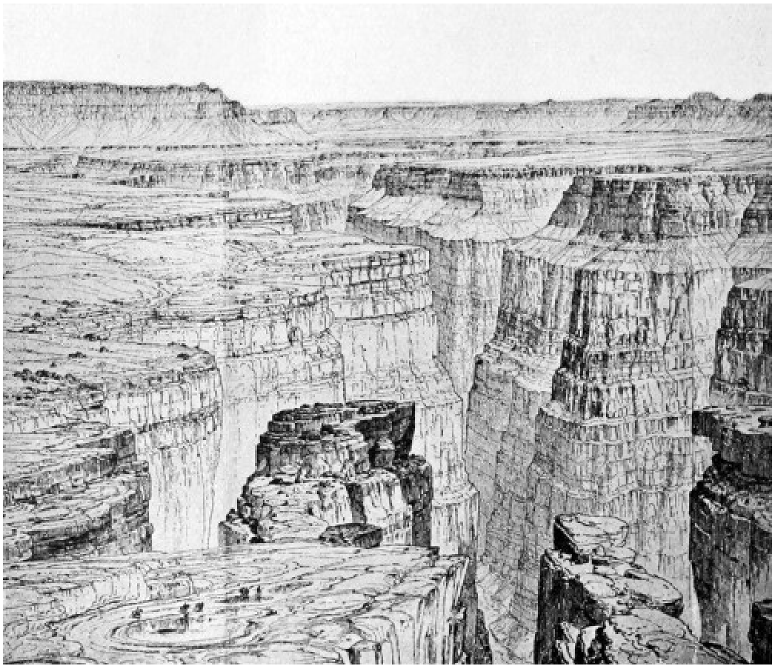


Fig. 8.—Horizontal Rocks, Grand Cañon of the Colorado.

These views have been selected in order that a comparison of this type of mountain structure may be made with that shown in Fig. 6. The points of resemblance between the two sections exposed, one by a steam shovel, the other by river action, are the horizontal position of the strata [Pg 473] [Pg 474] and the alternations of beds of unlike character. The differences are mainly that the beds making up the mountain show that they are built up of alternating layers of sand (now converted into a sandstone) and clay (now in the condition of a slate). Are not these the products of a decayed continent? Is their position to be explained otherwise than along the lines already stated? Our only difficulty in readily accepting this conclusion is founded on a hereditary belief, born in ignorance and nourished to maturity by superstition, that the earth came into existence as we see it to-day, the surface dissected by valleys in which the rivers find established courses to the sea; possessing a multiplicity of highland and lowland, granite mountains and marble hills, as a result of some plan carried into effect as a creative act. Science has revealed the impossibility of this interpretation. Considered in the light of evolution, acting through an immense period of time, by means of the processes already enumerated, the diversity of land form is made plain to us, and the ever-varying characters of rock structure and composition are in the main made easy of comprehension. Viewed in the light of the foregoing pages, and illustrating as they do land form and the greater part of the earth's crust, the rock structures revealed on the sides of the mountains and cañons, as well as the broader valley itself, take on a new and more intelligent interest. High and enduring as the mountains may appear, resistant as their solid rocks may seem, they are doomed as mountains to the same fate that their own structure and composition prove to have overtaken earlier mountains before them.

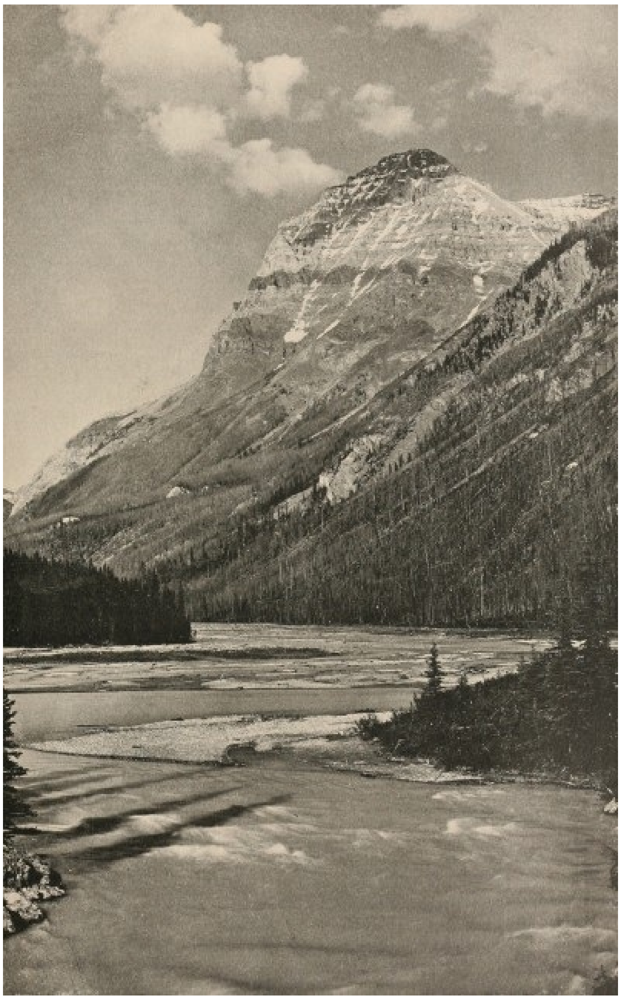


Fig. 9.—Mount Stephen, showing its Horizontal Rocks.

The earth has known no cessation in this cycle of decay, deposition, and elevation; again and again have continental masses been raised from the ocean floor only to become a prey to the forces that destroy them. These cycles will continue—mountain ranges will fade away and new ones will be born. A more permanent relationship between the lowland, the upland, and the ocean level will never be attained until the forces that warp and wrinkle the earth's crust shall have ceased forever.

M. Henri Bourget, of the Toulouse (France) Observatory, has called attention in Nature to a common phenomenon which he believes has not been mentioned in any scientific book. If one end of a bar of metal is heated, but not enough to make the other end too hot to be held in the hand, and then suddenly cooled, the temperature of the other end will rise till the hand can not bear it. All workmen who have occasion to handle and heat pieces of metal, he says, know this.

DEATH GULCH, A NATURAL BEAR-TRAP.

By T.A. Jaggar, Jr., Ph.D.

Cases of asphyxiation by gas have been very frequently reported of late years, and we commonly associate with such reports the idea of a second-rate hotel and an unsophisticated countryman who blows out the gas. Such incidents we connect with the supercivilization of the nineteenth century, but it is none the less true that Nature furnishes similar accidents, and that in regions far remote from the haunts of men. In the heart of the Rocky Mountains of Wyoming, unknown to either the tourist or the trapper, there is a natural hostelry for the wild inhabitants of the forest, where, with food, drink, and shelter all in sight, the poor creatures are tempted one after another into a bath of invisible poisonous vapor, where they sink down to add their bones to the fossil records of an interminable list of similar tragedies, dating back to a period long preceding the records of human history.

It was the writer's privilege, as a member of the expedition of the United States Geological Survey of the Yellowstone Park, under the direction of Mr. Arnold Hague, to visit and for the first time to photograph this remarkable locality. A similar visit was last made by members of the survey in the summer of 1888, and an account of the discovery of Death Gulch was published in Science (February 15, 1889) under the title A Deadly Gas Spring in the Yellowstone Park, by Mr. Walter Harvey Weed. The following extracts from Mr. Weed's paper indicate concisely the general character of the gulch, and the description of the death-trap as it then appeared offers interesting material for comparison with its condition as observed in the summer of 1897.

Death Gulch is a small and gloomy ravine in the northeast corner of the Yellowstone National Park. "In this region the lavas which fill the ancient basin of the park rest upon the flanks of mountains formed of fragmentary volcanic ejecta, ... while the hydrothermal forces of the central portion of the park show but feeble manifestations of their energy in the almost extinct hot-spring areas of Soda Butte, Lamar River, Cache Creek, and Miller Creek." Although hot water no longer flows from these vents, "gaseous emanations are now given off in considerable volume." On Cache Creek, about two miles above its confluence with Lamar River, are deposits of altered and crystalline travertine, with pools in the creek violently effervescing locally. This is due to the copious emission of gas. Above these deposits "the creek cuts into a bank of sulphur and gravel cemented by this material, and a few yards beyond is the *débouchure* of a small lateral gully [Pg 476]
coming down from the mountainside. In its bottom is a small stream of clear and cold water, sour with sulphuric acid, and flowing down a narrow and steep channel cut in beds of dark-gray volcanic tuff. Ascending this gulch, the sides, closing together, become very steep slopes of white, decomposed rock.... The only springs now flowing are small oozes of water issuing from the base of these slopes, or from the channel bed, forming a thick, creamy, white deposit about the vents, and covering the stream bed. This deposit consists largely of sulphate of alumina.... About one hundred and fifty feet above the main stream these oozing springs of acid water cease, but the character of the gulch remains the same. The odor of sulphur now becomes stronger, though producing no other effect than a slight irritation of the lungs.

"The gulch ends, or rather begins, in a scoop or basin about two hundred and fifty feet above Cache Creek, and just below this was found the fresh body of a large bear, a silver-tip grizzly, with the remains of a companion in an advanced stage of decomposition above him. Near by were the skeletons of four more bears, with the bones of an elk a yard or two above, while in the bottom of the pocket were the fresh remains of several squirrels, rock hares, and other small animals, besides numerous dead butterflies and insects. The body of the grizzly was carefully examined for bullet holes or other marks of injury, but showed no traces of violence, the only indication being a few drops of blood under the nose. It was evident that he had met his death but a short time before, as the carcass was still perfectly fresh, though offensive enough at the time of a later visit. The remains of a cinnamon bear just above and alongside of this were in an advanced state of decomposition, while the other skeletons were almost denuded of flesh, though the claws and much of the hair remained. It was apparent that these animals, as well as the squirrels and insects, had not met their death by violence, but had been asphyxiated by the irrespirable gas given off in the gulch. The hollows were tested for carbonic-acid gas with lighted tapers without proving its presence, but the strong smell of sulphur, and a choking sensation of the lungs, indicated the presence of noxious gases, while the strong wind prevailing at the time, together with the open nature of the ravine, must have caused a rapid diffusion of the vapors.

"This place differs, therefore, very materially from the famous Death Valley of Java and similar places, in being simply a V-shaped trench, not over seventy-five feet deep, cut in the mountain slope, and not a hollow or cave. That the gas at times accumulates in the pocket at the head of the gulch is, however, proved by the dead squirrels, etc., found on its bottom. It is not probable, however, that the gas ever accumulates here to a considerable depth, owing to the open nature [Pg 477]
of the place, and the fact that the gulch draining it would carry off the gas, which would, from its density, tend to flow down the ravine. This offers an explanation of the death of the bears, whose remains occur not in this basin, but where it narrows to form the ravine, for it is here that the layer of gas would be deepest, and has proved sufficient to suffocate the first bear, who was probably attracted by the remains of the elk, or perhaps of the smaller victims of the invisible gas; and he, in turn, has doubtless served as bait for others who have in turn succumbed. Though the gulch has doubtless served as a death-trap for a very long period of time, these skeletons and bodies must be the remains of only the most recent victims, for the ravine is so narrow and the fall so great that the channel must be cleared out every few years, if not annually. The change

wrought by the water during a single rainstorm, which occurred in the interval between Mr. Weed's first and second visits, was so considerable that it seems probable that the floods of early [Pg 478] spring, when the snows are melting under the hot sun of this region, must be powerful enough to wash everything down to the cone of *débris* at the mouth of the gulch." Mr. Arnold Hague, on the occasion of his visit, was more successful in obtaining evidence of the presence of carbonic-dioxide gas. He writes: "The day I went up the ravine I was able in two places to extinguish a long brown paper taper. The day I was there it was very calm, and where I made the test the water was trickling down a narrow gorge shut in by shelving rocks above."

It was at noon on the 22d of July in the summer of 1897 that we made camp near the mouth of Cache Creek, about three miles southeast of the military post and mail station of Soda Butte. In company with Dr. Francis P. King I at once started up the creek, keeping the left bank, that we might not miss the gulch, which joins the valley of Cache Creek from the southern side. We had a toilsome climb through timber and over steep embankments, cut by the creek in a loose conglomerate, and after going about a mile and a half we noticed that some of these banks were stained with whitish and yellow deposits of alum and sulphur, indicating that we were nearing the old hot-spring district. Soon a caved-in cone of travertine was seen, with crystalline calcite and sulphur in the cavities, and the bed of the creek was more or less completely whitened by these deposits, while here and there could be seen along the banks oozing "paint-pots" of calcareous mud, in one case inky black, with deposits of varicolored salts about its rim, and a steady ebullition of gas bubbles rising from the bottom. In other cases these pools were crystal clear, and always cold. The vegetation, which below had been dense close to the creek's bank, here became more scanty, especially on the southern side, where the bare rock was exposed and seen to be a volcanic breccia, much decomposed and stained with solfataric deposits. A mound of coarse *débris* seen just above on this side indicated the presence of a lateral ravine, which from its situation and character we decided was probably the gulch sought for. A strong odor of sulphureted hydrogen had been perceptible for some time, and when we entered the gully the fumes became oppressive, causing a heavy burning sensation in the throat and lungs. The ravine proved to be as described, a V-shaped trench cut in the volcanic rock, about fifty feet in depth, with very steep bare whitish slopes, narrowing to a stony rill bed that ascended steeply back into the mountain side.

General View, looking downstream, of Lower Part of Death Gulch.

Climbing through this trough, a frightfully weird and dismal place, utterly without life, and occupied by only a tiny streamlet and an appalling odor, we at length discovered some brown furry masses lying scattered about the floor of the ravine about a quarter of a mile from the point [Pg 479] where we had left Cache Creek. Approaching cautiously, it became quickly evident that we had before us a large group of huge recumbent bears; the one nearest to us was lying with his nose between his paws, facing us, and so exactly like a huge dog asleep that it did not seem possible that it was the sleep of death. To make sure, I threw a pebble at the animal, striking him on the flank; the distended skin resounded like a drumhead, and the only response was a belch of poisonous gas that almost overwhelmed us. Closer examination showed that the animal was a young silver-tip grizzly (*Ursus horribilis*); a few drops of thick, dark-red blood stained his nostrils and the ground beneath. There proved to be five other carcasses, all bears, in various stages of decay; careful search revealed oval areas of hair and bones that represented two other bears, making a total of eight carcasses in all. Seven were grizzlies, one was a cinnamon bear (*Ursus americanus*). One huge grizzly was so recent a victim that his tracks were still visible in the [Pg 480] white, earthy slopes, leading down to the spot where he had met his death. In no case were any marks of violence seen, and there can be no question that death was occasioned by the gas. The wind was blowing directly up the ravine during our visit, and we failed to get any test for carbonic acid, though we exhausted all our matches in the effort, plunging the flames into hollows of the rill bed in various parts of its course; they invariably burned brightly, and showed not the slightest tendency to extinguish. The dilution of the gas in such a breeze would be inevitable, however; that the gas was present was attested by the peculiar oppression on the lungs that was felt during the entire period that we were in the gulch, and which only wore off gradually on our return to camp. I suffered from a slight headache in consequence for several hours.

Looking down the Gulch—the Latest Victim, a Large Silver-Tip Grizzly.

There was no difference in the appearance of the portion of the gulch where the eight bears had met their end and the region above and below. A hundred yards or more up stream the solfataric deposits become less abundant, and the timber grows close to the brook; a short distance beyond this the gulch ends. No bodies were found above, and only bears were found in the locality described. It will be observed that Weed's experience differs in this respect from ours, and the appearance of the place was somewhat different: he found elk and small animals in addition to the bears, and describes the death-trap as occupying the mouth of the basin at the head of the gulch, above the point where the last springs of acid water cease. The rill observed by us has its source far above the animals; indeed, it trickles directly through the worm-eaten carcass of the cinnamon bear—a thought by no means comforting when we realized that the water supply for our camp was drawn from the creek only a short distance down the valley.

It is not impossible that there may be two or three of these gullies having similar properties. That we should have found only bears may perhaps be accounted for on the ground that the first victim for this season was a bear, and his carcass frightened away all animals except those of his own family. For an illustration of a process of accumulation of the bones of large vertebrates, with all the conditions present necessary for fossilization, no finer example can be found in the world than Death Gulch; year after year the snow slides and spring floods wash down this fresh supply of entrapped carcasses to be buried in the waste cones and alluvial bottoms of Cache Creek and Lamar River. Probably the stream-formed conglomerate that we noted as we ascended the creek is locally filled with these remains.

The gas is probably generated by the action of the acid water on the ancient limestones that here underlie the lavas at no great depth; outcrops of these limestones occur only a few miles away at the mouth of Soda Butte Creek. This gas must emanate from fissures in the rock just above the bears, and on still nights it may accumulate to a depth of two or three feet in the ravine, settling in a heavy, wavy stratum, and probably rolling slowly down the bed of the rill into the valley below. The accompanying photographs were made during our visit. [Pg 481]

THE LABOR PROBLEM IN THE TROPICS.

By W. ALLEYNE IRELAND.

A great deal of space has been devoted in American magazines and newspapers recently to the question of how this country has become a colonial power. Destiny and duty, strength and weakness, accident and design, honesty and corruption have been called on by writers, singly and in various combinations, to bear the responsibility of the new departure in the national policy.

Whatever interest such speculations may possess for the student who seeks to discover in the events of history some indication of the evolution of national character, there can be little doubt that the eyes of the people at large are turned in another direction.

What are our new possessions worth? is the question which intelligent men of all classes are beginning to ask; and it is not surprising, in view of the comparative isolation of this country in the past, that there are few who have sufficient confidence in their own opinion to answer the query.

In England, whose colonial and Indian empire embraces nearly one fourth of the population of the globe, there is an astounding lack of knowledge in relation to colonial affairs; and those who follow the debates in the House of Commons will have noticed that when the colonies are the subject under discussion the few members who remain in their seats seldom fail to exhibit a degree of ignorance which must be most disheartening to the able and learned Colonial Secretary.

It is not to be wondered at, then, that in the United States, where the people have been too much occupied with the problems continually arising at home to pay any attention to affairs which, until very recently, have appeared entirely outside the range of practical politics, there should be few men who have given their time to that careful study of tropical colonization which alone can impart any value to opinions in regard to the practical issues involved in the colonial expansion of [Pg 482] this country. Discussion of the subject has been almost entirely along the line of the possible effects of the new policy on the political institutions and popular ideals of the United States, and little has been written which may be said to throw any light on the problem of tropical colonization *per se*.

A residence of ten years in the tropical colonies of France, Spain, Holland, and Great Britain—a period during which I devoted much time to the study of colonial affairs—leaves me of opinion that there are two points in regard to which discussion is peculiarly opportune: 1. The value of the Philippines and Puerto Rico as a field for the cultivation of those tropical products which are consumed in the temperate zones. 2. The value of the islands as a market for products and manufactures of the temperate zones.

It will at once be seen that only in so far as the islands are valuable in the former respect can they be important in the latter, for in the absence of production there can not be any considerable consumption of commodities.

The first point to be considered, and it is the one to which I shall confine myself in the present article, is by what means the productive possibilities of Puerto Rico and the Philippines can be developed.

Basing my calculation on official reports covering a number of years, I find that the average value *per capita* of the annual exports of native products from a number of tropical colonies selected by me for the purpose of this inquiry is as follows:

Trinidad	$26.48	Dominica	$7.28
British Guiana	34.26	St. Vincent	7.68
Martinique	23.48	Ceylon	7.24
Mauritius	20.28	Montserrat	7.89

An examination of these figures will serve to show that the value of the colonies in the first column, measured by the standard of their productiveness, is three times that of the colonies in the second column. Reference to the population returns of the colonies named discloses the fact that in the colonies in the first column the population contains a very large proportion of imported contract laborers and their descendants, while in the other colonies practically the whole population is home-born for at least two generations.

A moment's reflection will show the importance of the comparison instituted above, and if the space at my command permitted a more extensive analysis of the trade of tropical colonies, it could be demonstrated that the theory holds good, almost without exception, that of tropical countries those only are commercially valuable in which a system of imported contract labor is in force.

There are one or two colonies (Barbados is the most striking example) in which the pressure of population is so great that the labor supply suffices for the utmost development of which the [Pg 483] country is capable; but such instances are rare.

The experience of England in governing tropical colonies is frequently cited by those who favor the so-called imperial policy for the United States as a proof that tropical colonization in itself presents no difficulties which can not be overcome by enlightened administration. It would be difficult to point out in just what manner Great Britain derives any benefit from her tropical possessions, but her experience confirms the theory I have stated above—that the commercial development of tropical colonies is possible only where there is an extraordinary density of population or where a system of imported contract labor is in force.

A glance through the list of Great Britain's tropical colonies will serve to prove the correctness of this theory. Imported contract labor is used in British Guiana, Trinidad, Jamaica, Queensland, the Fiji Islands, the Straits Settlements, and Mauritius; while the pressure of population is extreme in Lagos and Barbados, which support respectively 1,333 and 1,120 persons to the square mile.

The remaining tropical colonies of Great Britain—using the term "tropical colony" in its strictest sense—are the Gold Coast, Sierra Leone, Gambia, Hongkong, St. Helena, British Honduras, Grenada, St. Vincent, St. Lucia, Antigua, St. Kitts-Nevis, Dominica, Montserrat, and a few islands in the Pacific which are insignificant commercially.

A careful examination of the British trade returns shows that the total export and import trade between the United Kingdom and all the British tropical colonies in 1896 reached a value of $146,000,000, and that of this sum $121,000,000 represented trade with the tropical colonies which employ imported contract labor and with Lagos and Barbados. In other words, the trade between the United Kingdom and those British tropical colonies where free labor is used and where there is no great pressure of population made up less than eighteen per cent of the total trade with the British tropical colonies.

It would appear from the facts I have given that the commercial development of those parts of the tropics where the population is sparse will be dependent on the importation of labor from more densely peopled areas.

If the question is approached from an entirely different standpoint the necessity of contract labor in the tropics becomes more strikingly apparent. The development of the tropics will be in the direction of agriculture rather than manufacturing, and the requirements of tropical agriculture in respect of labor are most arbitrary. It is not sufficient that the labor supply is ample, in the ordinary sense of the word; it must be at all times immediately available.

Thus, a mine owner whose men go out on strike is, briefly, placed in this position: He will lose a sum of money somewhat larger than the amount of profit he could have made during the period of the strike had it not occurred. His coal, however, is still there, and is not less valuable—indeed, in the case of a prolonged strike, may actually be more valuable—when the strike is over; work can easily be resumed where it was dropped, and during the idle days the ordinary running expenses of the mine cease. The greater part of the loss sustained in the instance I have supposed is not out-of-pocket loss, but merely the failure to realize prospective profits. [Pg 484]

On the other hand, a sugar estate in the tropics spends about eight months out of the twelve in cultivating the crop, and the remaining four in reaping and boiling operations. By the time the crop is ready to reap many thousands of dollars have been expended on it by way of planting, weeding, draining, and the application of nitrogenous manures. If from any cause the labor supply fails when the cutting of the canes is about to commence, every cent expended on the crop is wasted; and if for want of labor the canes which are cut are not transported within a few hours to the mills, they turn sour and can not be made into sugar. It will thus be seen that in the case of sugar-growing a perfectly reliable labor supply is the first requisite.

The same might be said of the cultivation of tea, coffee, cocoa, spices, and tropical fruits.

This problem—the securing of a reliable labor supply—has been solved in the case of several of the tropical possessions of England by the importation of East Indian laborers under contract to serve for a fixed period on the plantations.

As, in my opinion, the East Indian contract laborer will play an important part in the development of the tropics, I describe in detail the most perfect system of contract labor with which I am acquainted, that existing at the present time in the colony of British Guiana. The system of imported indentured labor which is in force in many of the British colonies has been referred to frequently, both in this country and in England, as "slavery," "semislavery," "the new slavery." The use of such terms to describe such a system indicates a complete ignorance of the facts. As some of the best-informed journals in this country, in noticing my writings on tropical subjects, have fallen into this error, I hope that the description I give here, which is based on several years' experience of the actual working of the system, will serve to convince the readers of this article that the indenture of the East Indian coolie in the British colonies is no more a form of slavery than is any contract entered into between an employer and an employee in this country.

When the British Guiana planter was informed by the home Government in 1834 that four years later slavery would be entirely abolished throughout the British Empire, he foresaw at once that unless a new source of labor was thrown open a very short time would elapse before the cane fields would fall out of cultivation. He listened, not without some irritation, to the assurances of the agents of the Antislavery Society that as soon as the slaves were freed they would work with redoubled energy, and that the labor supply, instead of deteriorating, would, in fact, improve. The planters knew better, and began at once to arrange for the importation of contract labor. With the year 1834 began the period of apprenticeship for the slaves, prior to their complete emancipation four years later. [Pg 485]

During this time, and before the imported labor sufficed for the needs of the plantations, several estates were ruined and fell out of cultivation because the apprenticed laborers would not work.

On October 11, 1838, the governor of the colony, Henry Light, Esquire, issued a proclamation to the freed slaves. The proclamation stated that the governor had learned with regret that the labor of the freed slaves was irregular; that their masters could not depend on them; that they worked one day and idled the next; that when they had earned enough to fill their bellies they lay down to sleep or idled away their time; that they left their tasks unfinished, and then expected to be paid in full for them.

In the meanwhile the planters imported labor from the West Indian Islands, Malta, Madeira, China, and Germany; and eventually the system of immigration from India was organized.

The system is under the control of the Indian Council in Calcutta on the one hand and the British Guiana Government and the Colonial Office on the other. In Georgetown, the capital of the colony, is the immigration department, under the management of the immigration agent general, who has under him a staff of inspectors, subagents, clerks, and interpreters, all of whom must speak at least one Indian dialect. In Calcutta resides the emigration agent general, also an official of the British Guiana Government, who has under him a staff of medical officers, recruiting agents, and clerks.

Each year the planters of British Guiana send in requisitions to the immigration department stating the number of immigrants required for the following year. These requisitions are examined by the agent general, and if, in his opinion, any estate demands more coolies than the extent of its cultivation justifies, the number is reduced. As soon as the full number is decided on, the agent in Calcutta is informed, and the process of recruiting commences. The laborers are secured entirely by voluntary enlistment. The recruiting agents go about the country and explain the terms offered by the British Guiana planters, and those men and women who express their [Pg 486] willingness to enter into a contract are sent down to Calcutta at the expense of the colony.

On arrival in Calcutta they are provided with free food and quarters at the emigration depot until such time as a sufficient number are assembled to form a full passenger list for a transport. During the period of waiting, which may extend to several weeks, a careful medical inspection of the laborers is made, and all those who may be deemed unfit for the work of the estates are sent back to their homes at the expense of the colony. Prior to embarkation the coolies are called up in batches of fifteen or twenty, and the emigration agent or a local magistrate reads over to them in their own language the terms of the indenture. Each one is then given an indenture ticket on which the terms of indenture are printed in three dialects. The agent general affixes his signature to each ticket; and a special provision in the laws of British Guiana makes his signature binding on the planters who employ the coolies. The ticket thus constitutes a contract valid as against either party in the courts of the colony.

The coolies have the right to carry with them any children they may wish, and those under twelve years of age are exempt from indenture. The transportation is effected in sailing vessels, which are for the time being Government transports. The reason why steamers are not employed is that sailing vessels are found to be much healthier, and that the long sea voyage has an excellent effect on the immigrants. The regulations governing the voyage are very strict. As far as the coolies are concerned, the ship is in charge of a medical officer. The captain of the ship, the officers, and the crew are all under the command of the doctor, except in so far as the actual sailing of the vessel is in question. The vessel has ample hospital accommodation, a complete dispensary in charge of a qualified dispenser, and all the arrangements must be passed by a Government inspector before the ship is given her clearance. The food to be furnished during the voyage is specified by law. The bill of fare consists chiefly of bread, butter, rice, curry, sago, condensed milk, and fresh mutton, a number of sheep being carried on the ship.

Every morning and evening the doctor makes an inspection of the vessel, and enters in his log-book all essential details, such as births, deaths, cases treated in the hospital, and so forth.

On arrival in the colony the coolies are allotted to the different estates. The coolie is bound to remain for five years on the plantation to which he is allotted, and to work during that time five days a week, the day's work being seven hours. In return for this the planter must furnish him with a house free of rent, and built in such a way as to meet the requirements of the inspector of immigrants' dwellings in regard to ventilation, size, and water supply; and no immigrants are [Pg 487] sent to any estate until these houses have been inspected and passed as satisfactory. The planter must also furnish on the estate free hospital accommodation and medical attendance, and in addition provide free education for the children of indentured immigrants.

The medical officers are Government servants, and the colony is divided into districts, each of which has its own doctor, who is compelled by law to visit each estate in his district at least once in forty-eight hours and examine and prescribe for all immigrants presenting themselves at the hospital.

The planter is further bound to pay a minimum daily wage of twenty-four cents to each man and sixteen cents to each woman. This appears at first sight a very small sum, but when it is taken into account that a coolie can live well on eight cents a day it will be seen that the wage is three times the living expense, a rate very rarely paid to agricultural laborers in any part of the world.

That the coolies do, in fact, save considerable sums of money will be seen when the statistics of the immigration department are examined. These records show that during the years 1870 to 1896 38,793 immigrants returned to India after completing their terms of indenture, and that they carried back with them to their native land over $2,800,000. At the end of 1896 there were over five thousand East Indian depositors in the British Guiana Government Savings Bank and the Post-Office Savings Bank, with a total sum of more than $450,000 to their credit.

At the end of five years the indentured coolie becomes absolutely free. He may cease work, or, if he prefer it, remain on the estates as a free laborer. The whole colony is open to him, and he may engage in any trade or profession for which he may be fitted. If he remains for five years longer in the colony, even though he be idle during the whole of that time, he becomes entitled to a grant of land from the Government. The law in this respect has been recently changed. All coolies who came to the colony prior to 1898 have the choice at the end of ten years of a free grant of land or an assisted passage back to their native place.

It may be objected by those persons who are unacquainted with the system that all this sounds very well on paper, but that the opportunities for fraud and oppression must be very frequent, and, human nature being what it is, very frequently taken advantage of, to the injury of the coolies' interests. Such charges have, in fact, been made from time to time, but they have, on investigation, proved to be unfounded, or, at the worst, highly exaggerated. The treatment of the indentured immigrants in British Guiana was the subject of a Royal commission of inquiry in [Pg 488] 1870. The appointment of the commission followed a series of charges made by a certain Mr. Des Voeux, a magistrate in the colony, in a letter to Earl Granville, at that time Secretary of State for the Colonies.

The commission visited the colony and conducted a most searching inquiry. Hundreds of witnesses were examined, and the commissioners visited several estates, without giving any warning of their intentions, and questioned many of the coolies as to their treatment. Mr. Des Voeux entirely failed to substantiate his charges; and Sir Clinton Murdoch, the chairman of the emigration board—a permanent department of the Colonial Office—in referring to the report of the commission in a blue book issued in 1872, said: "It may, I think, be considered that the report of the commissioners is generally satisfactory, both as regards the magistracy, the planters, and the immigrants. Many defects in the system and mode of working it are no doubt pointed out, but they are defects caused by errors of judgment, by insufficiency of the law, or by want of foresight, not by intentional neglect or indifference to the well-being of the people, still less by oppression or cruelty. The vindication of the magistracy and of the medical officers appears to be complete, and the fair dealing and kindness of the managers toward the immigrants is acknowledged."

The laws have been amended, the Government inspection has been made more complete, and to-day it is impossible that any abuse of power on the part of the planters can pass unnoticed.

To give an instance of the effectiveness of the Government supervision—each estate is compelled by law to keep pay lists according to a form specified by the immigration department, in which the name of each indentured immigrant must be entered with a record of each separate day's work during the five years of the indenture. Thus, if the pay list shows that in a certain week a man worked only two days out of the legal five, it must also show the reason why he did not work on the other three days. It may have been that the man was in the hospital, in which case the letter "H" must appear opposite his name for those days; or he may have been granted leave of absence, when the letter "L" would account for him. These pay lists are inspected by a Government officer twice a month, and any faults disclosed by the examination become the subject of a severe reprimand from the agent general, followed in the case of persistent neglect by the cutting off of the supply of coolies.

So minute are the records of the immigration department that were an application made to the agent general for information regarding some particular indentured coolie, that official could without difficulty supply the name of the man's father and mother, his caste, age, native place, [Pg 489] with the same information in regard to the man's wife. He could also make out an account showing every day the man had worked during the term of his indenture, and the reasons why he had not worked on the other days, with the exact amount earned on each working day. In addition to this he could state how many days the man had spent in the estate's hospital and what was the matter with him on those occasions, besides furnishing a copy of every prescription made up for the man in the estate's dispensary.

A striking evidence of the desire of the Government to protect the coolies from ill treatment of any kind is afforded by the rule of the immigration department that, if any overseer on an estate is convicted of an offense against an indentured immigrant, the dismissal of the offender is demanded, and each estate in the colony is warned that if it employ the man the supply of immigrants will be cut off.

The coolies are given every facility to complain of ill-treatment or breach of contract on the part of the planters, for, in addition to the opportunity afforded by the regular visits of the subagents, the right is secured to them by law of leaving any estate without permission in order to visit the agent general or the nearest magistrate; and either of these officials has the power to issue all process of law free of cost to any coolie who satisfies him that there is a *prima facie* cause of complaint.

Such, in brief, are the features of the East Indian immigration system of British Guiana.[12]

Those who approach the question of the labor supply for the American colonies with an unprejudiced mind will see that there is nothing in the system I have described which is at [Pg 490] variance with the principles of the American people.

All that is required to make such a system a boon both to the employer and to the laborer is that the officials charged with the inspection of the system and the protection of the immigrants' interests should be intelligent, honest, and fearless in the discharge of their duties.

PRINCIPLES OF TAXATION.

By the Late Hon. DAVID A. WELLS.

XX.—THE LAW OF THE DIFFUSION OF TAXES.

PART II.

Attention is next asked to an analysis of the incidence of taxation, what is mainly direct, on processes and products, and on the machinery by which one is effected and the other distributed, and at the outset the following propositions in the nature of economic axioms are submitted, which it is believed will serve as stepping stones to the attainment of broad generalizations.

Thus, property is solely produced to supply human wants and desires; and taxes form an important part of the cost of all production, distribution, and consumption, and represent the labor performed in guarding and protecting property at the expense of the State, in all the processes of development and transformation. The State is thus an active and important partner in all production. Without its assistance and protection, production would be impeded or wholly arrested. The soldier or policeman guards, while the citizen performs his labor in safety. As a partner in all the forms of production and business, the State must pay its expenses—i.e., its agents, for their services; and its only means of paying are through its receipts from taxation. Taxes, then, are clearly items of expense in all business, the same as rent, fuel, cost of material, light, labor, waste, insurance, clerical service, advertising, expressage, freight, and the like, and on business principles they find their place on the pages of profit and loss; and, like all other expenses which enter into the cost of production, must finally be sustained by those who gratify their wants or desires by consumption. Production is only a means, and consumption is the end, and the consumer must pay in the end all the expenses of production. Every dealer in domestic or imported merchandise keeps on hand, at all times, upon his shelves, a stock of different and accumulated taxes—customs, internal revenue, State, school, and municipal—with his goods; and when we buy and carry away from any store or shop an article, we buy and carry away with it the [Pg 491] accompanying and inherential taxes.

Any primary taxpayer, who does not ultimately consume the thing taxed, and who does not include the tax in the price of the taxed property or its products, must literally throw away his money and must soon become bankrupt and disappear as a competitor; and accordingly the tax advancer will add the tax in his prices if he understands simple addition. How rapidly bankruptcy would befall dealers in imported goods, wares, and merchandise in the United States who did not strictly observe this rule will be realized when one remembers that the average tax imposed by its Government (in 1896) on all dutiable imports is in excess of fifty per cent.

When Dr. Franklin was asked by a committee of the English House of Commons, prior to the American Revolution, if the province of Pennsylvania did not practically relieve farmers and other landowners from taxation, and at the same time impose a heavy tax on merchants, to the injury of British trade, he answered that "if such special tax was imposed, the merchants were experts with their pens, and added the tax to the price of their goods, and thus made the farmers and all landowners pay their part of the tax as consumers."

Taxes uniformly levied on all the subjects of taxation, and which are not so excessive as to become a prohibition on the use of the thing taxed, become, therefore, a part of the cost of all production, distribution, and consumption, and diffuse and equate themselves by natural laws in the same manner and in the same minute degree as all other elements that constitute the expenses of production. We produce to consume and consume to produce, and the cost of consumption, including taxes, enters into the cost of production, and the cost of production, including taxes, enters into the cost of consumption, and thus taxes levied uniformly on things of the same class, by the laws of competition, supply, and demand, and the all-pervading mediums of labor, will be distributed, percussed, and repercussed to a remote degree, until they finally fall upon every person, not in proportion to his consumption of a given article, but in the proportion his consumption bears to the aggregate consumption of the taxed community.

A great capitalist, like Mr. Astor, bears no greater burden of taxation (and can not be made to bear more by any laws that can be properly termed tax laws) than the proportion which his aggregate individual consumption bears to the aggregate individual consumption of all others in his circuit of immediate competition; and as to his other taxes, he is a mere tax collector, or conduit, conducting taxes from his tenants or borrowers to the State or city treasury. A whisky distiller is a tax conduit, or tax collector, and sells more taxes than the original cost of whisky, as [Pg 492] finds proof and illustration in the fact that the United States imposes a tax of one dollar and ten cents per gallon on proof whisky which its manufacturer would be very glad to sell free of tax for an average of thirteen cents per gallon. The tax, furthermore, is required to be laid before the whisky can be removed from the distillery or bonded warehouse and allowed to become an article of merchandise. Tobacco in like manner can not go into consumption till the tax is paid. In Great Britain, where all tobacco consumed is imported, for every 3*d.* paid by the consumer, 2.5*d.* represents customs duties or taxes. In Russia it is estimated that the Government annually requires of its peasant producers one third the market value of their entire crop of cereals in payment of their taxes, and fixes the time of collecting the same in the autumn, when the peasant sells sufficient of his grain (mainly for exportation), and with the purchase money meets the demands of the tax collector. Can it be doubted that the sums thus extorted enter into and form an essential part of the cost of the entire crop or product of the land? It is, therefore, immaterial where the process of manufacture takes place; the citizens of a State pay in proportion to the quantity which they consume. The traveler who stops at one of the great city hotels can not avoid reimbursing the owner for the tax he primarily pays on the property; and the owner, in respect to the taxation of his hotel property, is but a great and effective real-estate and diffused tax collector. Again, the farmer charges taxes in the price of his products; the laborer, in his wages; the clergyman, in his salary; the lender, in the interest he receives; the lawyer, in his fees; and the manufacturer, in his goods.

The American Bible Society is always in part loaded with the whisky and tobacco taxes paid by the printers, paper-makers, and book-binders, or by the producers of articles consumed by these mechanics, and reflected and embodied in their wages and the products of their labor according to the degree of absence of competition from fellow-mechanics who abstain from the use of these and other taxed articles.

These conclusions respecting the diffusion of taxes may be said to be universally accepted by economists so far as they relate to the results of production before they reach the hands of the final consumers; but they are not accepted by many, as Mr. Henry George has recently expressed it, in respect to taxes on special profits or advantages on things of which the supply is strictly limited, or of wealth in the hands of final consumers, or in the course of distribution by gift, and finally in respect to taxes on land. But a little examination would seem to show that all of these exceptions are of the kind that are said to prove the rule. *Special profits* and advantages in this age of quick diffusion of knowledge and intense competition are exceedingly ephemeral, and are [Pg 493] mainly confined to results which the State with a view of encouraging removes for a limited time from the natural laws of competition by granting patents, copyrights, and franchises. Of things which are strictly limited in respect to supply, what and where are they? Only a very few can be specified: ivory, Peruvian guano, whalebone, ambergris, and the pelts of the fur seal. Of wealth in the process of transmission, or in the hands of final consumers, it is not *tangible* wealth unless it is *tangible* property, which conforms under any correct system of taxation to the principles of taxation; and if any one advocates the taxation of the right to receive property which has already been taxed, he in effect advocates a double exaction of one and the same thing. If it be asked, Will an income tax on a person retired from business be diffused? the answer, beyond question, must be in the affirmative, if the tax is uniform on all persons and on all amounts, and is absolutely collected in minute sums. Would any one pay the same price for a railroad bond which is subject to an income tax as he would for it if it was free from tax? If one's land is taxed, either in the form of rent or income, will not the tenant have the burden primarily thrown upon him? And, finally, will not the consumer of the tenant's goods pay through or by reason of such consumption?

Respecting the incidence of the tax on mortgages, it does not make any difference how mortgages are taxed—no earthly power can make the lender pay it. If the borrower would not agree to pay the tax, the lender would not loan him money, and whenever possible loans would be foreclosed and payment insisted upon if the borrower should refuse to pay the tax.

Let us next subject to analysis the incidence of the so-called taxation of land. Considered *per se* (or in itself), land, in common with unappropriated air and water, has no value; and it can not in any strict sense be affirmed that we tax land; and when such affirmation is made, its only legitimate and justifiable meaning is that we tax the value of land; which value is due entirely to the amount of personal property (in the sense of embodied labor) expended upon it, and the pressure or demand of such property or labor to use, possess, and occupy it.

Vattel, in his Law of Nations, enunciates as a self-evident and irrefutable proposition that "Nature has not herself established property, and in particular with regard to lands. She only approves this introduction for the advantage of the human race."

One of the most striking examples of evidence in illustration and proof of this proposition is to be found in an incident, which has heretofore escaped attention, which occurred during a debate in the Senate of the United States in 1890 on a bill for revision of duties on imports, in respect to [Pg 494] the article borax (borate of soda). Formerly the world's supply of this mineral substance, which enters largely into industrial processes and medicine, was limited, and mainly derived from certain hot springs in Tuscany, Italy; but within a comparatively recent period it has been found that it exists in such abundance in certain of the desert regions of California, Nevada, and Arizona, that it can be gathered with the minimum of labor from the very surface of the ground. Were a single acre of similar desert to be found in any section of a country enjoying the most ordinary privileges in respect to transportation and water supply, it would be a source of wealth to its proprietor. But under existing circumstances, although thousands and thousands of acres of this land can be bought with certain title from its owner—the Federal Government—for two dollars and twenty-five cents an acre, no one wants it at any price; and the prospective demand for it has not yet been sufficient to warrant the Government in instituting even a survey as a preliminary to effecting a sale. In the Senate debate above alluded to it was proposed to increase the duty on imported borax, with the expectation that a consequent increase in its domestic price would afford sufficient profit to induce such construction of roads and such a supply of water and labor on the borax tracts of the deserts as to enable them to become property.[13]

In the oases of the deserts of North Africa and Egypt the value of a tract of land depends very little upon its size or location, but almost exclusively upon the number of the date-bearing palms, the result of labor, growing upon it, and the quality of their fruit. John Bright on one occasion stated that if the land of Ireland were stripped of the improvements made upon it by the labor of the occupier, the face of the country would be "as bare and naked as an American prairie."

An exact parallel to this state of things is afforded in the case of lands of no value reclaimed from the sea and made valuable, as has been often done in England, Holland, and other countries, by embodying labor upon them in the shape of restraining embankments and the transportation and use of filling material. Again, the value of springs or running streams of water is generally limited and of little account. But when, through direct labor, or the results of labor, the water is collected in reservoirs and made the instrumentality of imparting power to machinery, or conducted [Pg 495] through conduits to centers of population which otherwise could not obtain it, it becomes extremely valuable, and capable of being sold in large or small quantities. Another similar illustration is to be found in the case of atmospheric air, which in its natural and ordinary state has no marketable value, but when compressed by labor embodied in the form of machinery and made capable of transmitting force, it at once becomes endowed with value and can be sold at a high price.

An opinion entertained and strongly advocated by not a few economic writers and teachers of repute (more especially in Europe, but not in the United States)[14] is, that taxes on land do not diffuse themselves, but fall wholly on the landowner, and that there is no way in which he can throw it off and cause any considerable part of them to be paid by anybody else. The concrete argument in support of this opinion has been thus stated: "When land is taxed, the owner can not, as a general rule, escape the tax, for the reason that, to get rid of the tax, the price of the land or of the rent must be raised the full amount of the tax, and the only way in which this can be done is by reducing the supply or quantity offered in market, or else by increasing the demand. The supply of land can not be reduced, and the demand being created by capital and population, both of which are beyond the control of the landowner, he can do nothing to raise the price of land, and hence can not get rid of the tax. It may be stated, then, as a general rule, that a tax on land, or on any commodity the supply of which is limited absolutely, must be paid by the owner. It is possible to suggest cases in which, through combination of owners and the necessities of consumers, a demand may be created strong enough to raise the price to the full amount of such tax, but it is doubted if such cases ever really occur."[15]

The source of the contention on this important economic and social question, and the difficulty in the way of the attainment of harmonious conclusions, is due to a nonrecognition of the fact that land is taxed under two conditions, and can not be taxed otherwise. Thus, if a person holds land for his exclusive use or enjoyment, and consumes all of its product, a tax on such land, which has been characterized by some economists as its "pure rent," will not diffuse itself, because it is a [Pg 496] tax on personal enjoyment or final consumption. The same is the case when a portion of a river or lake or its shore is rented for fishing for the purposes of sport. A like result will also follow, in a greater or less degree, from the inability or unwillingness of tenants, as has been often the case in Ireland, to pay rent sufficient to reimburse the landowner for interest on his investment of capital and cost of repairs. But if one employs land as an instrumentality for acquiring gain through its uses, the taxation of land must include the taxation of its uses—its contents, all that rests upon it, all that is produced, sold, expended, manufactured, or transported on it—and all such taxes will diffuse themselves. On the other hand, if the taxation of land under such circumstances and conditions does not diffuse itself, then the taking is simply a process of confiscation, which if continued will ultimately rob the owner of his property, and is not governed by any principle.

It is indeed difficult to see how a theory so wholly inapplicable to fact and experience as that of the nondiffusion of taxes on land—which makes property in land an exception to the rule acknowledged to be applicable to all other property—could originate and be strenuously maintained to the extent even of stigmatizing any opposite view "as so very superficial as scarcely to deserve a refutation."[16] No little of confusion and controversy on this subject has arisen from the assumption that land specifically, and the rent of land, constitute two distinct and legitimate subjects for taxation, when the fact is just the contrary. The rent of land is in the nature of an income to its owner; and it is an economic axiom that when a government taxes the income of property it in reality taxes the property itself. In England and on the continent of Europe land is generally taxed on its yearly income or income value, and these taxes are always considered as land taxes. Alexander Hamilton, in discussing the taxation of incomes derived directly from property, used this language: "What, in fact, is property but a fiction, without the beneficial use of it? In many instances, indeed, the income is the property itself." The United States Supreme Court, in its recent decision of the income tax (1895), also practically indorsed this conclusion. To levy taxes on the rent of land and also upon the land itself is, therefore, double taxation on one and the same property, which in common with all other unequal and unjust taxes can not be diffused; and for this reason should be regarded as in the nature of exactions or confiscation, concerning the incidence of which nothing can be safely predicated. In short, this whole discussion, and the unwarranted assumption involved in it and largely accepted, is an illustration of what may be regarded as a maxim, that the greatest errors in political economy have arisen from overlooking the most obvious facts or deductions from experience. [Pg 497]

With a purpose of further elucidating this problem, attention is asked first to its consideration from an "abstract," and next from a practical standpoint of view. Let us endeavor to clearly understand the common meaning of the word "*rent*." It is derived from the Latin *reddita*, "things given back or paid," and in plain English is a word for price or hire. It may be the hire of anything. It is the price we pay for the right of exclusive use over something which is not our own. Thus we speak of the rent of land, of buildings and apartments, of a fishery, of boats, of water, of an opera box, of a piano, sewing machines, furniture, vehicles, and the like. In Scotland at the present time farmers hire cows to dairymen, who pay an agreed-upon price by the year or for a term of years for each cow, and reimburse themselves for such payment and make a profit on the transaction by the sale of the products of the animal. This hire is called a rent, and is clearly the same in kind as the rent of land. We do not apply the word "hire" to the employment of men, because we have a separate word—"wages"—for that particular case of hire. Neither do we apply the word "rent" in English to the hire of money, because we have another separate word —"interest"—which has come into special use for the price paid for the loan or hire of money. But in the French language the word *rent* is habitually and specially used to signify the price of the hire money, and that of "*rentes*" to investments of money paying interest; the French national debt being always spoken of as "*les rentes*"; while the men who live on the lending of money, or capital in any form, are called "*rentiers*."

The question next naturally arises, Why is it necessary to set up any special theory at all about the natural disposition of the price which we pay for the hire of land, any more than about the price we pay for the hire of a house, of furniture, of a boat, of an opera box, or of a cow? The particular kind of use to which we put each of these various things is no doubt very different from the kind of use to which we put each or all the others. But all of these uses resolve themselves into the desire we have to derive some pleasure or some profit by the possession for a time of the right of exclusive use of something which is not our own, and for which we must pay the price, not of purchase, but of hire.

The explanation of this curious economic phenomenon is to be found in the assumption and positive assertion on the part of not a few distinguished economists that the truly scientific and only correct use of the term "rent" is its application to the "income derived from things of all kinds of which the supply is limited, and can not be increased by man's action."[17] As a rule, [Pg 498] economists who accept this definition confine its application to the hire of land alone, although it professes to include other things, "of all kinds," to which the same description applies—namely, that they can not be increased in quantity by any human action. There are, however, no such other things specified, and in any literal sense there are no such other things existing, unless water and the atmosphere be intended.

Now, although it is indisputably true that man by his action can not increase the absolute or total quantity of land, any more than of water and air, appertaining to the whole globe on which we live, there is practically no limitation to the degree of value which man's action can impart to land, and which is the only thing for which land is wanted, bought, or sold, and which, as already shown, can be truly made the subject of taxation. The tracts of land on the earth's surface which are of no present marketable value are its deserts, its wildernesses, the sides and summits of its mountains, and its continually frozen zones, where no results of labor are embodied in or reflected upon it; while, on the other hand, its tracts of greatest value are in the large cities and marts of trade and commerce, as in the vicinity of the Bank of England, or in Wall Street, where the results of labor are so concentrated and reflected upon land that it is necessary to cover it with gold in order to acquire by purchase a title to it and a right to its exclusive use. The difference between land at twenty-five dollars an acre and twenty-five dollars a square foot is simply that the latter is or may be in the near future covered or surrounded by capital and business, while the former is remote from these sources of value. One of the greatest possible, perhaps probable, outcomes of the modern progress of chemistry is that through the utilization of microbic organizations the value of land as an instrumentality for the production of food may be increased to an extent that at the present time is hardly possible of conception. Again, in the case of air and water, although their total absolute quantity can not be increased, their available and useful quantity in any place, as before shown, can be by the agency of man, and their use made subject to hire or rent.

Consideration is next asked to the question at issue from what may be termed its practical standpoint. We have first a proposition in the nature of an economic axiom, that the price of everything necessary for production, or the hire of anything—land, money, and the like—without which the product could not arise, is, and must be, without exception, a part of the cost of that product; second, that all levies of the State which are worthy of being designated as taxes constitute an essential element of the cost of all products. The rent of an opera box, given to [Pg 499] obtain a mere pleasure, constitutes a part of the fund out of which the musicians are paid, and if they are not so paid they will not play or sing. The rent given for the right to fish on a certain part of a river or its shores is a part of the cost of producing the fish as a marketable commodity. If a house is hired for the purpose of conducting any business in it, the price of that hire does most certainly enter into the cost of that business, whatever it may be, assuming that the use of the house is a necessity for carrying it on. As no man will produce a commodity by which he is sure to lose money, or fail to obtain the ordinary rate of profit, the tax must be added to the price, or the production will cease. If a uniform tax is imposed on all land occupied, it will be paid by the occupier, because occupation (house-building) will cease until the rent rises sufficiently to cover the tax. The landlord assesses upon his tenants the tax he has paid upon his real estate; each tenant assesses his share upon each of his customers; and so perfect is this diffusion of land taxation that every traveler from a distant part of the country who remains for even a single day at a hotel pays, without stopping to think about it, a portion of the taxes on the building, first paid by the owner, then assessed upon the lessees, and next cut up by them minutely in the *per diem* charge. But of course neither the owner nor lessee really escapes taxation, because a portion of somebody else's tax is thrown back upon them.

Is it possible to believe that in a city like New York, where less than four per cent of its population pay any direct tax on real estate, or in a city like Montreal, where the expenses of the city are mainly derived from taxes on land and the building occupancy of land, the great majority of the inhabitants of those cities are exempt from all land taxation? In China, where, as before shown, the title or ownership of all land vests in the emperor, and the revenue of the Government is almost exclusively derived from taxation of land in the form of rent, does the burden of tax remain upon the owner of the land? If the tax in the form of rent is paid in the products of the land, as undoubtedly it is in part, will not the cost of the percentage of the whole product of the land that is thus taken increase to the renter the cost of the percentage that is left to him; or, if the product is sold for money with which to pay the tax rent, will not its selling price embody the cost of the tax, as it will the cost of every other thing necessary for production? To affirm to the contrary is to say that the price which the Chinese farmer pays for the right of the exclusive use of his land is no part of the crops he may raise upon it.

Consider next the assertion of those who maintain the nondiffusion theory that taxes on land are paid by the owners because the supply of land can neither be increased nor diminished. In [Pg 500] answer to it we have the indisputable fact that the owners of land, whenever taxes are increased, attempt to obtain an increased rental for it if the circumstances will permit it. And the very attempt tends to increase the rent. Nothing but adverse circumstances, such as diminishing population or commercial and industrial distress, can prevent a rise in the rental of land on which the taxes are increased; and in the case of dwellings and warehouses the rise is almost always very prompt, because no man will erect new dwellings or warehouses unless their rent compensate fully the increase of taxation. And in any prosperous community, in which population increases in the natural ratio, there must be a constant increase of dwellings and warehouses to prevent a rise of rent, independent of higher wages and higher taxation. In no other occupation is capital surer of obtaining the average net remuneration than in the erection of dwellings and warehouses, and nothing but lack of general prosperity and diminishing population can throw the burden of taxation on real estate or its owners, without the slightest attempt at combination on their part. If the owners of land are not reimbursed for its taxation by its occupants, new houses "would not be erected, the old ones would wear out, and after a time the supply would be so small that the demand would raise rents, and house building begin again, the tax having been transferred to the occupier."

It is pertinent at this point to notice the averment that is frequently made, that cultivators of the soil can not incorporate taxes on the land in the price of their products, because the price of their whole crop is fixed by the price at which any portion of it can be sold in foreign markets. In answer to this we have first the fact that, to give the population of the world an adequate supply of food and other agricultural products, it is not only necessary that all the land at present under cultivation shall continue to be so employed, but further that new lands shall each year be brought under cultivation, or else the land already cultivated shall be made more productive.

The population of the world steadily increases, notwithstanding wars, epidemics, and all the evils which are consequences of man's ignorance and of his improper use of things, his own faculties included. Hence, in case of increased taxation on land, the cultivator of the soil is generally enabled to transfer easily and promptly the burden of the tax to the purchasers of the products he raises, without abandoning the cultivation even of the least productive soil.

Furthermore, the exports of many agricultural products are due not to the cheapness of their cost of production, but to the variations which occur in the productiveness of the crops of other countries. M. Rouher, a French economist, and for a period a minister of commerce, thoroughly [Pg 501] investigated this matter, and proved by incontestable data that almost invariably when the yield of breadstuffs in Europe was large in the country drained by the Black and Baltic Seas, it was small in the countries drained by the Atlantic. This variation in the yield of agricultural crops forces the countries where crops are deficient to purchase from those where they are abundant, or who have a surplus on hand from previous abundant harvests. In the United States, when the harvests are abundant, the American farmers, rather than sell below a certain price, keep a portion of their crops on hand until bad crops in Europe produce a foreign demand, which has to be supplied at once. Under such circumstances those who hold the surplus stock of breadstuffs, or any other product, would control the price, and not the foreigners who stand in need of it. The only check, then, to the cupidity of the holders of breadstuffs is the competition between themselves, which invariably suffices to prevent any undue advantage being taken of the necessities of the countries whose harvests are deficient. These bad crops occur frequently enough to consume all the surplus of the countries that produce in excess of their own wants. In fact, this transient, irregular demand is counted upon and provided for by producers just as much so as the regular home demand—hence is one of the elements that regulate production and control prices.

At this point of the discussion it is desirable to obtain a clear and true idea of the meaning or definition of the phrase "diffusion of taxes." As sometimes used in popular and superficial discussions, it is held to imply that every tax imposed by law distributes itself equitably over the whole surface of society. Such implication would, however, be even more fallacious than an assumption that every expenditure made by an individual distributes itself in such a way that it becomes equally an expenditure by every other individual. On the other hand, a fair consideration of the foregoing summary of facts and deductions would seem to compel every mind not previously warped by prejudice to accept and indorse the following as great fundamental principles in taxation: *First*, that in order to burden equitably and uniformly all persons and property, for the purpose of obtaining revenue for public purposes, it is not necessary to tax primarily and uniformly all persons and property within the taxing district. *Second*, equality of taxation consists in a uniform assessment of the same articles or class of property that is subject to taxation. *Third*, taxes under such a system equate and diffuse themselves; and if levied with certainty and uniformity upon tangible property and fixed signs of property, they will, by a diffusion and repercussion, reach and burden all visible property, and also all of the so-called "invisible and intangible" property, with unerring certainty and equality. [Pg 502]

All taxation ultimately and necessarily falls on consumption; and the burden of every man, under any equitable system of taxation, and which no effort will enable him to avoid, will be in the exact proportion or ratio which his aggregate consumption maintains to the aggregate consumption of the taxing district, State, or community of which he is a member.

It is not, however, contended that unequal taxation on competitors of the same class, persons, or things diffuses itself whether such inequality be the result of intention or of defective laws, and their more defective administration. And doubtless one prime reason why economists and others interested have not accepted the law of diffusion of taxes as here given is that they see, as the practical workings of the tax systems they live under, or have become practically familiar with, that taxes in many instances do seem to remain on the person who immediately pays them; and fail to see that such result is due—as in the case of the taxation of large classes of the so-called personal property—to the adoption of a system which does not permit of equality in assessment, and therefore can not be followed by anything of equality in diffusion. Such persons may not unfairly be compared to physicists, who, constantly working with imperfect instruments, and constantly obtaining, in consequence, defective results, come at last to regard their errors as in the nature of established truths.[18]

According to these conclusions, the greatest consumers must be the greatest taxpayers. The man [Pg 503] also who evades a tax clearly robs his neighbors. The thief also pays taxes indirectly, for he is a consumer, and must pay the advanced price caused by his own roguery for all he consumes, although he does steal the money to pay with. Idlers and even tramps pay taxes, but the amount that they indirectly pay into the fund is much less than they take out of it. People are sometimes referred to or characterized as non-taxpayers, and in political harangues and socialistic essays measures or policies are recommended by which certain persons or classes, by reason of their extreme poverty, shall be entirely exempt from all incidence or burden of taxation. Such a person does not, however, exist in any civilized community. If one could be found he would be a greater curiosity than exists in any museum. To avoid taxation a man must go into an unsettled wilderness where he has no neighbors, for as soon as he has a companion, if that companion be only a dog, which he in part or all supports, taxation begins, and the more companions he has, [Pg 504] the greater improvements he makes, and the higher civilization he enjoys, the heavier will be the taxes he must pay.

Taxes *legitimately* levied, then, are a part of the cost of all production, and there can be no more tendency for taxes to remain upon the persons who immediately pay them than there is for rents, the cost of insurance, water supply, and fuel to follow the same law. The person who wishes to use or destroy the utility of property by consumption to gratify his desires, or satisfy his wants, can not obtain it from the owners or producers with their consent, except by gift, without giving pay or services for it; and the average price of all property is coincident with the cost of production, including the taxes advanced upon it, which are a part of its cost in the hands of the seller. Again, no person who produces any form of property or utility, for the purpose of sale or rent, sustains any burden of legitimate taxation, although he may be a tax advancer; for, as a tax advancer, he is the agent of the State, and a tax collector from the consumer. But he who produces or buys, and does not sell or rent, but consumes, is the taxpayer, and sustains a tax in his aggregate consumption, where all taxation must ultimately rest. In short, no person bears the burden of taxation, under an equitable, legitimate system, except upon the property which he applies to his own exclusive use in ultimate consumption. The great consumer is the only great taxpayer.

Finally, a great economic law pointed out by Adam Smith, which has an important and almost conclusive bearing upon this vexed problem of the diffusion of taxes, should not be overlooked—namely, his statement in The Wealth of Nations that "*no tax can ever reduce for any considerable time the rate of profit in any particular trade, which must always keep its level with other trades in the neighborhood*." In other words, taxes and profits, by the operation of the laws of human nature, constantly tend to equate themselves. Man is always prompted to engage in the most profitable occupation and to make the most profitable investment. And since the emancipation from feudalism with its sumptuary laws, legal regulations of the price of labor and merchandise, and other arbitrary governmental invasions of private rights, individual judgment and self-interest have been recognized as the best tests or arbiters of the profitableness of a given investment or occupation. The average profits, therefore, of one form of investment, or of one occupation (as originally shown by Adam Smith), must for any long period equal the average profits of other investments and occupations, whether taxed or untaxed, skill, risk, and agreeableness of occupation being taken into consideration.[19] Natural laws will, accordingly, always produce an equilibrium of burden between taxed and untaxed things and persons. There is a level of profit and a level of taxation by natural laws, as there is a level of the ocean by natural laws. In fact, all proportional contributions to the State from direct competitors are diffused upon persons and things in the taxing jurisdiction by a uniformity as manifest as is the pressure upon water, which is known to be equal in every direction.

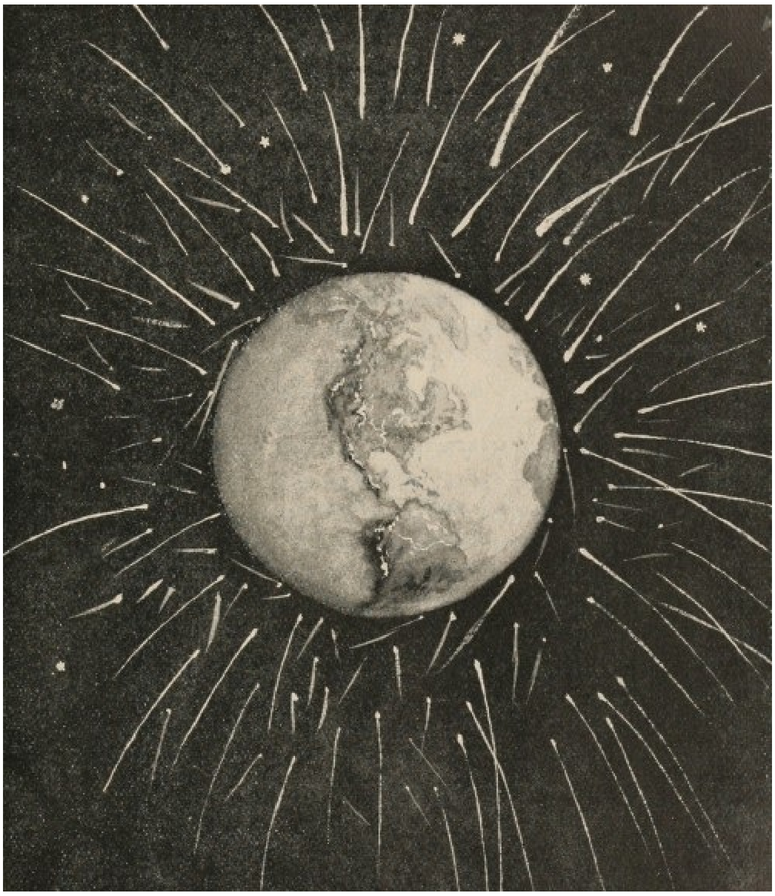
A word here in reference to the popular idea that the exemption of any form of property is to grant a favor to those who possess such property. This idea has, however, no warrant for its acceptance. Thus, an exemption is freedom from a burden or service to which others are liable; but in case of the exclusion of an entire class of property from primary taxation, no person is liable, and therefore there is no exemption. An exclusion of all milk from taxation, while whisky is taxed, is not an exemption, for the two are not competing articles, or articles of the same class. It is true that highly excessive taxation of a given article may cause another and similar article, in some instances, to become a substitute or competing article; and hence the necessity of care and moderation in establishing the rate of taxation. We do not consider that putting a given article into the free list, under the tariff, is an exemption to any particular individual; but if we make the rate higher on one taxpayer or on one importer of the same article than on another taxpayer or importer, we grant an exemption. We use the word "exemption," therefore, imperfectly, when we speak of "the exemption of an entire class of property," as, for example, upon all personal property; for if the removal of the burden operates uniformly on all interested, or owning such property, then there can be no primary exemption.

THE GREAT BOMBARDMENT.

By CHARLES F. HOLDER.

A thin stratum of air, an invisible armor of great tenuity, lies between man and the menace of possible annihilation.

The regions of space beyond our planet are filled with flying fragments. Some meet the earth in its onward rush; others, having attained inconceivable velocity, overtake and crash into the whirling sphere with loud detonation and ominous glare, finding destruction in its molecular armor, or perhaps ricocheting from it again into the unknown. Some come singly, vagrant fragments from the infinity of space; others fall in showers like golden rain; all constituting a bombardment appalling in its magnitude. It has been estimated that every twenty-four hours the earth or its atmosphere is struck by *four hundred million* missiles of iron or stone, ranging from an ounce up to tons in weight. Every month there rushes upon the flying globe at least twelve billion iron and stone fragments, which, with lurid accompaniment, crash into the circumambient atmosphere. Owing to the resistance offered by the air, few of these solid shots strike the earth. They move out of space with a possible velocity of thirty or forty miles per second, and, like moths, plunge into the revolving globe, lured to their destruction by its fatal attraction. The moment they enter our atmosphere they ignite; the air is piled up and compressed ahead of them with inconceivable force, the resultant friction producing an immediate rise in temperature, and the shooting star, the meteor of popular parlance, is the result.



Ideal View of the Earth as it is Bombarded by the Estimated Four Hundred Million Meteorites every Twenty-four Hours. [20]

A simple experiment, made by Joule and Thomson, well illustrates the possibility of this rise in temperature by atmospheric friction. If a wire is whirled through the air at a rate of one hundred and seventy-five feet per second, a rise of one degree, centigrade, will be noticed. If the revolutions are increased to three hundred and seventy-two feet per second, the elevation will be 5.3° C. If the temperature increases as the square of the velocity, a rate of speed of twenty miles [Pg 507] per second would develop a temperature not far from 360,000° C., which is probably far less than that at the surface of the ordinary meteor as it is seen blazing through our atmosphere. If the meteor is small it is often consumed by the intense heat generated; but larger fragments, owing to their velocity and the fact that they are poor conductors of heat and burn slowly, reach the surface and bury themselves in the sea or earth. But few escape the inevitable consequences of the contact, and of the untold millions which have struck the earth within the memory of man but five hundred and thirty have been seen to fall. The phenomena associated with the plunging meteor is most interesting. A blaze of light, as the terrific heat ignites the iron, announces its [Pg 508] entrance into our atmosphere. It may be red, yellow, white, green, or blue, all these hues having been observed. Then follows the explosion, caused by the contact with the air piled up ahead, and in certain instances a loud detonation or a series of noises is heard, which may be repeated indefinitely until the meteoric mass is completely destroyed, and drops, a shower of disintegrated particles, which fall rattling to the ground.

The blaze of light does not continue to the earth, nor does the meteor, should it survive, strike the ground with the velocity with which it entered the atmosphere, as the latter often arrests its motion so completely that it drops upon the earth by its own weight, well illustrated by the meteorites of the Hesslefall, which dropped upon ice but a few inches thick, rebounding as they fell. Thus the atmosphere protects the inhabitants of the globe from a terrific bombardment by destroying many of the largest meteorites, reducing the size of others before they reach the surface and arresting the velocity so that few bury themselves deeply in the soil.

The writer observed a remarkable meteor in 1894. It entered our atmosphere, apparently, over the Mojave Desert, in California, and exploded over the San Gabriel Valley, though without any appreciable sound, and after the first flash disappeared, leaving in the air a large balloon-shaped object of yellow light which lasted some moments, presenting a remarkable spectacle. In this instance the meteor had probably exploded or been consumed, leaving only the light to tell the story, the atmospheric armor of the earth having successfully warded off the blow.

Viewing the facts as they exist, the earth, a seeming fugitive mass flying through space, vainly endeavoring to break the bonds which bind it to the sun, hunted, bombarded with strange missiles hurled from unseen hands or forces from the infinity of space, it is little wonder that the ancients and some savage races of later times invested the phenomena with strange meanings. It requires but little imagination to see in the flying earth a living monster followed by shadowy furies which hurl themselves upon it, now vainly attempting to reach the air-protected body or again striking it with terrific force, lodging deep in its sides amid loud reverberation and dazzling blaze of light.

Meteorites have been known from the very earliest times, and have often been regarded as miraculous creatures to be worshiped and handed down from family to family. The famous meteorite which fell in Phrygia, centuries ago, was worshiped as Cybele, "the mother of the gods," and about the year 204 B.C. was carried to Rome with much display and ceremony, when people of all classes fell down before it, deeming it a messenger from the gods. Diana of Ephesus and the famous Cyprian Venus were, in all probability, meteoric stones which were seen to fall, and were worshiped for the same reason as above. Livy describes a shower of meteorites which fell about the Alban Mount 652 B.C. The senate was demoralized, and certain prophets announced it a warning from heaven, so impressing the lawmakers that they declared a nine-days' festival with which to propitiate the gods. The visitor to Mecca will find enshrined in a place of honor a meteorite which can be traced back beyond 600 A.D., and which is worshiped by pilgrims. The Tartars pointed out a meteorite to Pallas, in 1772, which had fallen at Krasnojarsk, and which they considered a holy messenger from heaven. A large body of meteoric iron found in Wichita County, Texas, was regarded by the Indians as a fetich. They told strangers that it came from the sky as a messenger from the Great Spirit. This meteorite was stationed at a point where two Indian trails met, and was observed and worshiped as a shrine. [Pg 509]

The Chinese have records of meteors which fell 644 B.C. The oldest authentic fall in which the stone is preserved is that of Ensisheim, Elsass, Germany, in 1492. The stone, which weighed two hundred and sixty pounds, fell with a loud roar, much to the dismay of the peasantry, penetrating the ground to a depth of five feet. It was secured by King Maximilian, who, after presenting the Duke Sigismund with a section, hung the remainder in the parish church as a holy relic, where, it is said, it may still be seen.

Meteorites vary in size from minute objects not larger than a pea to masses of iron of enormous size. The Chupaderos meteorite, which fell in Chihuahua, Mexico, weighs twenty-five tons. Another, which fell in Kansas, broke into myriads of pieces, the sections found weighing thirteen hundred pounds. A meteorite in the Vienna Museum, which fell in Hungary, weighs six hundred and forty-seven pounds, while the Cranbourne meteorite in the British Museum weighs four tons. The Red River meteorite in the Yale Museum weighs sixteen hundred and thirty pounds. The largest meteorite known was discovered within the Arctic Circle by Lieutenant Peary. The Eskimos had known of it for generations as a source of supply for iron. It was found by Lieutenant Peary in May, 1894, but, owing to its enormous weight, could not be removed until the summer of 1897, when, after much labor, it was excavated and hoisted into the hold of the steam whaling bark Hope and carried to New York, where it has found a resting place in the cabinet of the American Museum of Natural History. It is believed to weigh one hundred tons.

Up to 1772 the stories of bodies falling from space were not entertained seriously by scientific men. So eminent a scientist as Lavoisier, after thoroughly investigating a case, decided that it was merely a stone which had been struck by lightning. Falls finally occurred which demonstrated beyond dispute that the missiles came from space, and science recognized the fact that the earth was literally being bombarded, and that human safety was due to the atmospheric armor, scarcely one hundred miles thick, that enveloped the earth. Instances of the destruction of human life from this cause are very rare. Some years ago a meteorite crushed into the home of an Italian peasant, killing the occupant; and cattle have been known to be destroyed by them; but such instances are exceptional. In 1660 a meteorite fell at Milan, on the authority of the Italian physicist Paolo Maria Tezzayo, killing a Franciscan monk. Humboldt is authority for the statement that a monk was struck dead by a meteorite at Crema, September 4, 1511; and in 1674, on the same authority, a meteorite struck a ship at sea and killed two Swedish sailors. [Pg 510]

In December, 1795, at Wold Cottage, in Yorkshire, England, a stone weighing fifty pounds dashed through the air with a loud roar, alarming people in the vicinity, and burying itself in the ground not thirty feet from a laborer. This mass, though undoubtedly traveling, when it struck our atmosphere, at a rate of at least thirty miles a second, was checked so completely that it sank but twelve inches into the soft chalk. Great as is the heat generated during the passage of a meteorite through the air, it does not always permeate the entire body. This was well illustrated in the case of the meteorite which fell at Dhurmsala, Kangra, Punjaub, India, in 1860, fragments of which can be seen in the Field Museum in Chicago. Of it Dr. Oliver C. Farington says: "The fragments were so cold as to benumb the fingers of those who collected them. This is perhaps the only instance known in which the cold of space has become perceptible to human senses."

Some of the individual falls during recent years have attracted widespread attention. One of the most remarkable is known as the Great Kansas Meteor. It was evidently of large size, flashing into sight eighty or ninety miles from the earth, on the 20th of June, 1876, over the State of Kansas. To the first observers it appeared to come from the vicinity of the moon, and resembled a small moon or a gigantic fire ball, blazing brightly, and creating terror and amazement among thousands of spectators who witnessed its flight. It passed to the east, disappearing near the horizon in a blaze of light. The entire passage occupied nearly fifty seconds, being visible to the inhabitants of Iowa, Nebraska, Missouri, Indiana, Wisconsin, Illinois, Michigan, Kentucky, Ohio, Pennsylvania, and West Virginia.

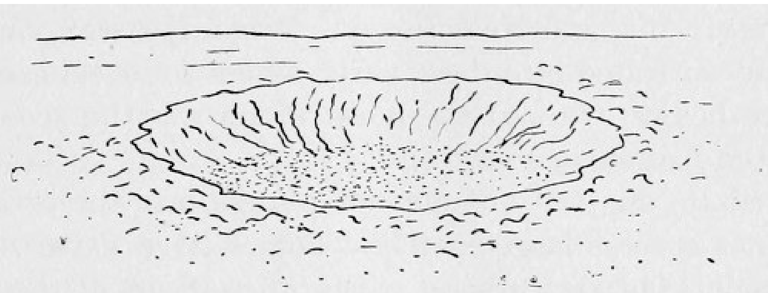
This visitor created the greatest alarm and apprehension along its path, the blaze of light being accompanied by repeated explosions and detonations which sounded like the rumble and roar of cannonading. To some it appeared like the rattling of heavy teams over a rough, rocky road; others believed subterranean explosions accompanied the fall. Horses ran away, stock hurried [Pg 511] bellowing to cover, and men, women, and children crouched in fear or fled before the fiery visitor whose roar was distinctly heard several minutes after it had disappeared. As the meteor crossed the Mississippi River the noise of the explosions increased in severity, and were distinctly heard sixty or seventy miles from its path, or a distance of one hundred and forty miles apart. The great ball of flame remained intact as it crossed five or six States, but as it passed over central Illinois loud detonations were heard and the light spread out like an exploding rocket with flashing points. This was the death and destruction of the monster, and from here it dashed on, a stream or shower of countless meteors instead of a solid body, forming over Indiana and Ohio a cluster over forty miles long and five in breadth, showing that while the meteor had broken up it was still moving with great velocity. How far it traveled is not known, as it was not seen to strike. Observers in Pennsylvania saw it rushing in the direction of New York, and people in that State, where the day was cloudy, heard strange rumblings and detonations. Houses rattled, and the inhabitants along the line the meteor was supposed to have passed accredited the phenomena to an earthquake. Somewhere, perhaps in the forest region of the Adirondacks, or in the Atlantic, lies the wreck of this meteor. But one fragment was found. A farmer in Indiana, while watching its passage heard the thud of a falling object, and going to the spot the following morning found a small meteorite weighing two thirds of a pound.

This marvelous body was first observed in all probability in the northwestern corner of the Indian Territory, possibly sixty or seventy miles above the earth, and from here it dashed along with repeated explosions, almost parallel to the earth's surface, disappearing over New York.

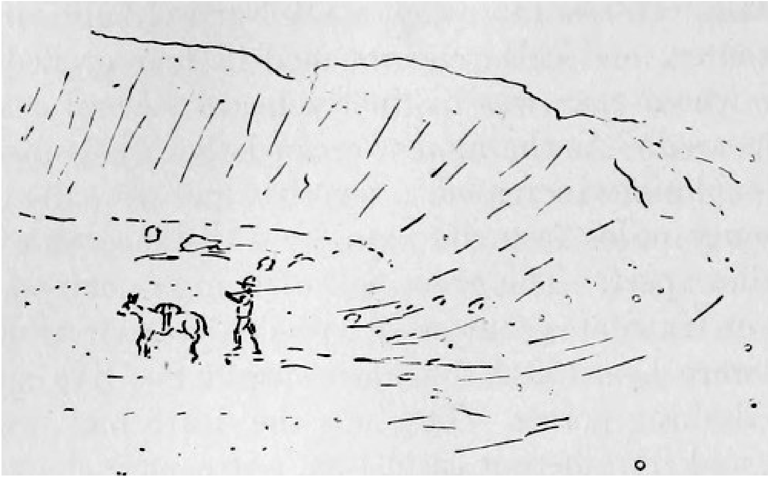
Another remarkable meteor fell into the Atlantic Ocean far out at sea, July 20, 1860. It resembled the one mentioned above in that it was accompanied by a marvelous pyrotechnic display. It first appeared in the vicinity of Michigan, blazing out with a fiery glow that filled the heavens with light. Cocks crowed, oxen lowed, and people rushed from their homes along its course over the States of New York, Pennsylvania, and New Jersey. When last seen, over the Atlantic, it had separated into three parts, which followed each other as separate fire bodies, without the noise which was the accompanying feature of the Kansas meteor. [Pg 512]

Doubtless the majority of meteors plunge into the ocean, and in modern times several large meteoric bodies have narrowly escaped passing vessels. On December 1, 1896, the officers of the ship Walkomming, bound from New York to Bremen, noticed a large and brilliant meteor flashing down upon them. Its direction was from southeast to northwest, and it plunged into the sea ahead of the vessel with a loud roar and hissing sound; a few minutes later an immense tidal wave, presumably caused by the fall, struck the ship, doing no little damage. Even more remarkable was the escape of the British ship Cawdor, which was given up by the underwriters, but which reached San Francisco November 20, 1897. During a heavy storm, August 20th, a large meteor flashed from the sky and passed between the main and mizzen masts, crashing into the sea with a blinding flash and deafening detonation. For a moment it was thought the ship was on fire, and the air was filled with sulphurous fumes.

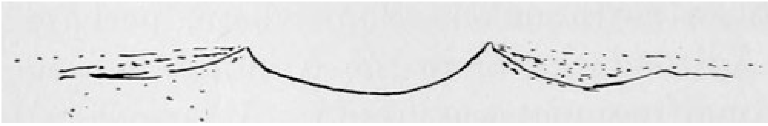
In 1888 a meteor dashed into the atmosphere of the earth and made a brilliant display over southern California. It appeared between twelve and one o'clock in the morning, and shot across the heavens, a fiery red mass—not like the ordinary meteor, but writhing and twisting in a manner peculiarly its own, resembling a huge serpent. When it had passed nearly across the sky it apparently stopped and doubled in the form of a horseshoe, according to the informant of the writer, as large as a half-mile race track. The horseshoe remained visible several minutes, gradually disappearing. The brilliancy of this meteor can be imagined when it is known that the entire San Gabriel Valley was illumined as though an electric light of great power had suddenly been flashed upon it. [Pg 513]



Coon Butte, on Slope of which Ten Tons of Meteoric Iron has been found, and which was supposed to have been made by a Meteor.

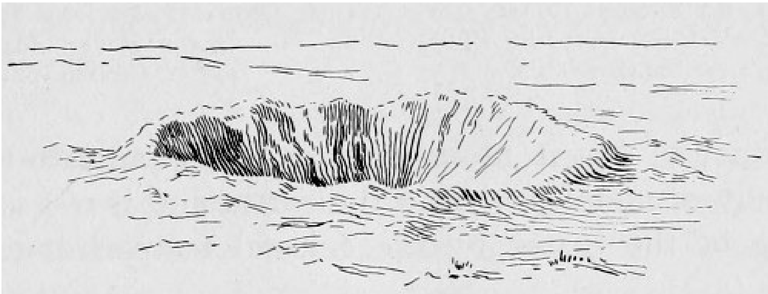


Section of Interior of Coon Butte.



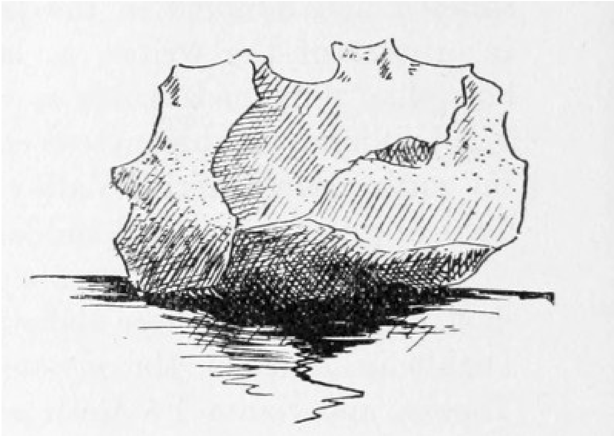
Section of Coon Butte.

Some time in past ages a meteorite weighing at least ten tons shot into our atmosphere and struck the earth near the famous Cañon Diablo in Arizona, the mysterious gulch crossed by the Atchison, Topeka and Santa Fé Railroad. The discovery was made several years ago by a sheep herder, named Armijo. Finding a piece of iron with a peculiar lustrous surface which he believed to be silver, he carried it to one of the towns, where it finally fell into the hands of a geologist, who pronounced it a meteorite. The discovery was followed up, and on the crest and in the vicinity of a singular cone about four thousand feet in diameter pieces of a meteorite were found on the surface, which gave a combined weight of ten tons, in all probability but a fraction of the real monster. The iron masses were widely scattered over the slope and the adjacent *mesa*, and it was assumed that a gigantic meteorite or star had fallen and produced the cone, another striking the earth and forming what is now known as the Cañon Diablo. A large piece of meteoric iron was found twenty miles from the cone; another eight miles east of it; two thousand pieces weighing not over a few pounds or ounces were taken from the slopes; two exceeding a thousand pounds were found within a half mile, while forty or fifty weighing about one hundred pounds were discovered within a radius of half a mile. Here not only a meteor, but a large-sized meteoric shower, had succeeded in penetrating the armor of the earth, leaving many evidences of the extraordinary occurrence which may have been witnessed by the early man of what is now known as Arizona. From the peculiar and interesting evidence a geologist deduced the hypothesis that [Pg 514] the crater known as Coon Butte could have been produced by a meteor with a diameter of fifteen hundred feet, and a careful examination with a view of discovering it was made with nicely adjusted magnetic instruments; but in no instance did they indicate the presence of a vast body of metal buried in the earth, and it was assumed that the striking of the crater by the colossal meteorite was a chance blow.

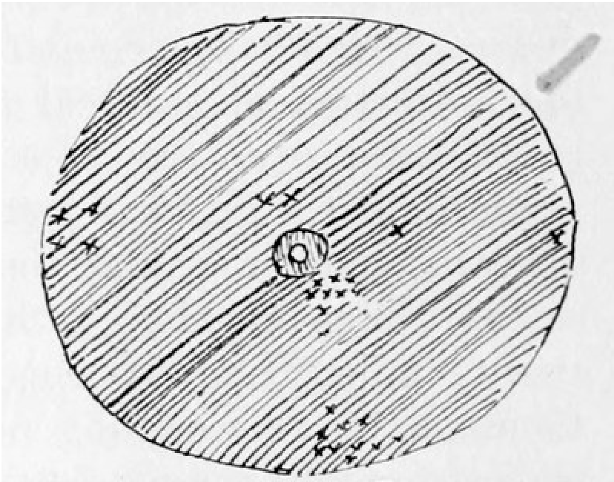


The Crater of Coon Butte near Cañon Diablo, near which the fragments of a meteorite have been found, and which was supposed at one time to have been made by the meteorite.

One Hundred and Sixty-one Pound Meteorite. A part of the ten-ton meteorite which fell at Coon Butte, near Cañon Diablo.



One Hundred and Sixty-one and a Half Pound Meteorite found near Crater of Coon Butte.



Crosses show Large Pieces of the Meteorite found at Coon Butte. (Seven miles in diameter.)

The meteorites or foreign bodies which bombard the earth may be included in three classes—meteoric irons or aërosiderites, meteoric iron stones or aërosiderolites, and meteoric stones, aërolites—all containing elements, about twenty-five in number, which have been found upon the earth. The most conspicuous and important are silicon, iron, nickel, magnesium, sulphur, carbon, and phosphorus, while the others are aluminum, antimony, arsenic, calcium, chlorine, chromium, cobalt, copper, hydrogen, lithium, manganese, oxygen, potassium, sodium, tin, and titanium. Hydrogen and the diamond have also been observed. A number of interesting chemical compounds are found in meteorites not known on the earth, and a study of their character shows that the conditions under which the meteors were formed were entirely different from those which saw the beginning of things terrestrial. In brief, where meteors were born there was an absence of air and water. On the other hand, there was at some stage in the history of meteorites an abundance of hydrogen. The meteoric irons are made up principally of iron with an alloy of nickel, and show a rich crystalline structure, the various angles producing a variety of forms [Pg 515] known as *Widmanstatten* figures which a few years ago formed the basis of a singular sensation. The figures were supposed to be fossil shells and various animals of a diminutive size which once populated the wrecked world of which the meteor was assumed to be a part. These meteoric animals from space were named and classified by several observers, who were finally forced to acknowledge that their creations were the fanciful markings of crystallization.

Another class of meteorites (meteoric iron stones) may be described as spongy masses of nickeliferous iron in whose pores are found grains of chryosite and other silicates. A type of these bodies is the meteor of Pallas, which was discovered by him in 1772. The third class of meteoric stones are those in which the stony or silicous predominates. As a rule they contain scattered metallic grains, but certain ones, as the aërolite which fell at Gara, France, in 1806, contain metallic constituents.

The aërolites present an attractive appearance when made into sections, showing crystals and splinterlike fragments, and under the glass seem to be made up of many minute spheres ranging from those the size of a cherry down to others invisible to the naked eye. The minerals prominent in their composition are chrysolite, bronzite, augite, enstatite, feldspar, chronite, etc., showing a marked similarity to the eruptive rocks so well known on the earth. The collections of famous meteorites in the various museums of the world have constantly been examined and studied with a view to determine their origin, the question being a fascinating one to layman and scientist. Astronomers in the past have variously answered the question. The flying fragments were believed by some to be the wreckage of other worlds. Planets had perhaps collided and been rent asunder in former ages, and space filled with the flying fragments. Others thought that meteors were molten matter thrown from the earth or moon. All these theories have been relinquished in view of evidence of a more or less convincing character pointing to the conclusion that the bombardment of the earth is one of the results of the disintegration of comets. In other words, cometary matter flying not always blindly through space, but in the orbit of the comet of which it originally formed a part, constituting the missiles.

It is known that the meteors were formed in a region where air and water were absent. It is equally evident that life was not a factor in the past history of the bodies, though it must be acknowledged that the hydrocarbons resembling terrestrial bitumens which are found in some meteorites suggest the possibility of vegetable life. These comets, the mysterious bodies which seem to be roving through space, misconceived planets, as it were, forced into the world half [Pg 516] made up, offer the best known solution, as they are literally worlds without air or water, enveloped in a strange and ever-changing substitute for atmosphere; ghostly worlds, which seem to be drawn to the sun, then thrown out into space again to repeat the act until the mighty change from close contact with the fiery mass to the intense cold of distant realms wrecks them, scatters their fragments through the infinity of space where they form gigantic rings or clusters of meteoric matter, raining down upon the sun and planets and all heavenly bodies which meet them, adding fuel to the former, material substance to the latter, and in the case of the moon pitilessly bombarding her crust—illustrating the effect of the bombardment of the earth were it deprived of its atmospheric armor.

The evidence which enabled astronomers to definitely associate comets with meteoric showers and falling stars leads one into a world of romance. Schiaparelli, the distinguished Italian astronomer, made the discovery that meteors had a cometic origin. He had been calculating the orbit and motion of the meteorites which produce the August showers, when it occurred to him that they corresponded with those of a certain comet. By following up this clew it was discovered that the orbit of Tempel's comet corresponded with that of the meteors of the November star shower. The most remarkable evidence was that produced by Biela's comet, discovered in 1826. It had a revolution about the sun of six years and eight months. It was seen in 1772, 1805, 1832, 1845, and 1852. The vast mass, which appeared to be rushing around the sun with remarkable velocity, became separated in 1846, dividing into two parts, one hundred and fifty thousand or two hundred thousand miles from each other. In six years the separation had increased to about one and a half million miles. What mighty cataclysm in infinite space caused this rupture the mind of man can not conceive, but something occurred which rent the aërial giant asunder, and so far as known completed its wreck, as from that time Biela's comet has not been seen. In 1872 the comet was looked for, and astronomers predicted that if it did not appear a shower of stars or meteors would be visible—the remains of the lost traveler through space—and that they would diverge from a point in Andromeda.

This remarkable prediction was verified in every particular. When the moment for the appearance of the comet arrived, November 27, 1872, there burst upon the heavens, not Biela's comet, but a marvelous shower of shooting stars, which dashed down from the constellation of Andromeda as predicted. In 1885 this was duplicated, and the atmosphere was apparently filled with shooting stars. Biela's comet had met disaster in infinite space, and the earth was being bombarded with the wreckage.

It is difficult to comprehend the vastness of these clusters of meteors which constitute the wreck [Pg 517] of comets and the source of the principal bombardments. Thus the August stream, which gives us the brilliant displays of summer nights, is supposed to be ten million miles in thickness, as the earth dashing through at a rate of two million miles a day is several days in passing it. We cross the November stream of meteors in a few hours, suggesting a width of forty thousand or fifty thousand miles. This stream of metallic bodies is hundreds of millions of miles in length, and contains myriads of projectiles which may yet be hurled upon the earth or some of the planets of the solar system.

The November Shower of Meteors at Sea from Sandy Hook.

But one piece of Biela's comet, so far as known, was found—a fragment weighing eight pounds falling at Mazapil, Mexico, where it remains one of the most inspiring and interesting of inanimate objects. For years the vast metallic mass, of which this piece formed a part, rushed through space, covering millions of miles; now near the burning surface of the sun, now in regions of space where its heat was scarcely perceptible. For over a century this monster was observed by the inhabitants of the earth, and finally a portion fell and human beings handled and examined it. [Pg 518]

The fiery messengers which dash down singly upon the earth, the showers of meteoric stones which flash through our atmosphere with ephemeral gleams, are, then, the remains of gigantic comets which have been seen rushing with apparent erratic course through space, and which by unknown causes have been destroyed and now as meteoric clusters, one of which is estimated to be one billion miles in length and one hundred thousand miles in thickness, and to contain one hundred thousand million meteors, are swinging through space, with many erratic and wandering forms, pouring upon the earth and all the planets of the solar system a mighty and continuous bombardment.

THE SPIRIT OF CONQUEST.

By J. NOVICOW.

The spirit of conquest produces a gigantic aggregation of calamities and sufferings. A large number of persons still regard conquests with a favoring eye. Now, what does a conquest signify? It is the arming of a band of soldiers and going and taking possession of a territory. Although such expeditions may appear useful, lucrative, legitimate, and even glorious, little regard is paid, in conducting them, to the good of societies; for, in spite of all euphemisms, such military enterprises are robbery, and nothing else, all the time.

Generous spirits who talk about suppressing war do great injury to mankind. Setting themselves in pursuit of a chimera, they abandon the road that leads to concrete and positive results. Realists treat the partisans of perpetual peace as Utopian dreamers, and refuse to follow them. The noblest and most generous efforts are thus wholly lost. The direction of public opinion is left to empirics and retrogrades, to narrow-minded people, who are satisfied with living from day to day and have not the courage to look the social problems of the time in the face. War will never be abolished any more than murder. The propaganda should not be directed on that side. The spirit of conquest is the thing to combat. And this colossal error must be fought not in the name of a vague and intangible fraternity, but by appealing to the egoistic interest of every one. There will always be wars, because man will never be absolutely sound-minded. At times passion and folly will prevail over reason. But the idea that conquest is the quickest means of increasing [Pg 519] prosperity will not be everlasting, because it is utterly false.

Man acts conformably to what seems to be his interest. The idea he has of this depends on his judgment, which varies every day, as do also his desires. There is only one efficacious method of effecting social changes: it is, to modify the desires of men, to bring them to seek new objects, different from the old ones.

A great many Germans are saying now, "We would give up the last drop of our blood rather than surrender Alsace-Lorraine." Why do they say that? Because the possession of the provinces annexed in 1871 procures them some sort of real or imaginary satisfaction. But if, on the other hand, this annexation caused them extreme sufferings, the Germans would say, "We would give up the last drop of our blood to get rid of Alsace-Lorraine." Now, if the Germans (or any other people) could comprehend how largely the spirit of conquest diminishes the sum of their enjoyment, they would certainly express themselves in language of the latter sort. The apostles of perpetual peace have therefore taken the wrong road. Their efforts should bear upon the single object of showing that the appropriation of a neighbor's territories in no way increases the welfare of men. The pessimists answer us that it will take many years for the uselessness of conquests to be accepted. Well, then, man shall have to continue many years in suffering; that is all there is of it.

When will the day come that we shall find out that it is no longer advantageous to seize a neighbor's territory? We do not know. The only thing we can affirm with absolute certainty is, that when it arrives our prosperity will be increased five or ten fold.[21]

This ctesohedonic error (lust for possession) has produced consequences of which we proceed to speak. Just as individuals fancy that they will be better off with larger possessions, so peoples imagine that their prosperity and happiness will be in direct proportion to the territorial extent of their country. Hence one of the silliest aberrations of the human mind—the fatuous idolatry of square miles. A great many Germans still figure it out that they will have a larger sum of [Pg 520] happiness if their country contains 208,670 square miles instead of 203,070.[22] Few errors are more evident. There are thousands of examples to prove that the welfare of citizens is in no way a function of the extent of the state. If it were so, Russia would be the richest country in Europe, while everybody knows it is exactly the contrary. Taxation in that country is pushed to limits that might almost be called absurd, and for that reason the extent of the nation is one of the greatest obstacles to its prosperity.

As an example to illustrate the absurdity of the idolatry of square miles, take California, which now has 158,360 square miles,[23] and 1,200,000 inhabitants. If in another century the population should rise to forty millions, it might be expedient for the good government of these men to divide the State into several. If the conservatives of that period should declare that they would give the last drop of their blood to preserve the unity of their Commonwealth, they would be afflicted with the square-mile craze, and as foolish as the Europeans. Territorial divisions are made for men, not men for territorial divisions. The object enlightened patriots should pursue is not that a certain geographical extent should be included under one name or many, but that the divisions should conform to the aspirations and desires of the citizens. They should impose as little restraint as possible upon the economical and intellectual progress of societies.

The inhabitants of the province of Rio Grande recently wanted to secede from Brazil. The Government at Rio Janeiro, afflicted like other governments by the square-mile craze, would not consent to it, and hostilities broke out. Suppose the Rio Grandians had been victorious in this war; what would have been the result? There would have been eleven states in South America instead of ten. No modern political theorist would see the presage of an extraordinary calamity in such an event as that. The new state would have been recognized by the other powers, and things would have gone on as before. But if the central Government, respecting the wishes of the Rio Grandians, had consented to the secession, the empirical politicians of our time would have affirmed that the world had been unbalanced. Yet the situation would have been exactly the same in point of territorial divisions—eleven independent states instead of ten. We have then to think that, in the eyes of modern politicians, the avoidance of a war, the fact of sparing hundreds of millions of money and thousands of human lives, diminishes wealth, while the waste of capital and massacres should increase it! It would be hard to be less logical or more absurd.

The great North American federation is composed of forty-four States, of from 1,250 square miles [Pg 521] (the size of Rhode Island) to 265,780 square miles (the size of Texas). If one hundred States should be established to-morrow of about 30,000 square miles each, there would not necessarily follow either an increase or a diminution of the welfare of the population. The Americans can make equally rapid progress whether divided into forty republics or one hundred, and as slow under one division as under the other. Wealth is not a function of political divisions. So Europe is now divided into twenty-four independent states, having from 8 to 2,100,000 square miles of territory. If it were divided to-morrow into one hundred independent states of 35,000 square miles each, it would as easily be poorer as richer. All would depend upon the interior organization of each of these states, and on the relations which they might establish with one another.

Very few persons understand this truth. When we see the most civilized nations of Europe imagining that their welfare depends on 5,000 or 6,000 square miles more or less, we stand really stupefied before the persistence of the ancient routines. The simple disarmament of three military corps would procure ten times as many benefits for the German people as the possession of Alsace-Lorraine. In short, as long as the false association between the territorial extent of a state and its wealth persists its progress in real wealth will be very slow.

To return to the spirit of conquest. A great many things, as we have shown in another place, are not appropriable. Foreign territories are not so for entire nations. A military chief with his staff may be better off through the conquest of a country, but a nation never.

When William of Normandy seized England he committed an act that was not according to his interest as properly understood. He destroyed by war a considerable quantity of wealth, and he and his barons in turn suffered by the general diminution of welfare. These sufferings were, however, infinitesimal and very hard to appreciate. True views of the nature of wealth were, moreover, not accessible to the brains of men of the eleventh century. Certainly, when William and his army had possessed themselves of England they experienced an increase of wealth that was very evident to them. The king had more revenue; every Norman soldier got land or a reward in money, and he became richer after Hastings than he had ever been before.

But what did the Roman *people*, for example, gain by the conquest of the basin of the Mediterranean? Four or five hundred grand personages divided the provincial lands alienated by the state among themselves, but what benefit did the masses derive from the bloody campaigns [Pg 522] of the republic? The distribution of the *annone*, 280 grammes of bread each a day, given to 200,000 persons out of the 1,500,000 inhabitants of the Eternal City! Surely the Romans would have gained a great deal more by working themselves than by pillaging other nations!

Things are exactly the same now. In 1871 twenty-eight persons received from the Emperor William donations forming a total of $3,000,000. But what benefit did the German *people* derive from the conquest of Alsace-Lorraine? None. Dividing the 3,600,000 acres of that province among the 6,400,000 families that were living in Germany at the time of the Treaty of Frankfort would make two and a half acres each. This is not opulence. Of the 5,000,000,000 of francs extorted from France as damage for the expenses of the war there remained 3,896,250,000 francs, which, divided among 6,400,000 families, represent a gain of 609 francs, or about $121.80 per family—hardly enough to live scantily upon for four months; and this was the most lucrative war of which history makes mention! Consider, further, at what amount of sacrifice these $121.80 have been gained. In 1870 the military expenses of the North German Confederation and the four southern states amounted to 349,000,000 francs a year. They now exceed 795,000,000, and in another year (from 1894) will exceed 870,000,000. Here, then, is an increase of 521,000,000 francs, or a charge of 60 francs per family. As 609 francs, even at five per cent, will only return 30 francs, we have here a clear loss of 30 francs (or $6) a family per year. It thus appears that the conquest of Alsace-Lorraine would have been a bad speculation, even if the French indemnity had been distributed in equal parts among all the German families. But, in fact, it has not been so; so that the 60 francs of supplementary expenditure are paid without any compensation.

It might be said that the conquest of Alsace-Lorraine was not dictated solely by sordid economical considerations. Other interests, purer and more elevated, stir the hearts of modern nations. But we ask, Is it grand, noble, and generous to hold unwilling populations under the yoke? On the contrary, it is most base, vile, and degrading. It is difficult to comprehend how brutal conquest can still arouse enthusiasm. Ancient survivals and routines must for a time have suppressed all our reflective faculties.

Suppose, again, 3,000,000 German soldiers should penetrate into Russia and should gain a complete victory: how would they apportion the territory? The parts here would indeed be larger—Russia contains 5,471,500,000 acres. But a third of this territory, at least, is desert; subtracting this, there remain about 3,600,000,000 acres, which, divided among the German families, would [Pg 523] give about 5-1/2 acres to each. It may be asked, How will the conquerors take possession of these lands? If each family delegated only one of its members, that would suppose an exodus of 6,400,000 men, going to scatter themselves from the Vistula to the Amoor. What a disturbance so great an emigration would make in the economical condition of Germany! Moreover, would every German colonist be willing to leave his home, his family, his business, and all his cherished associations, to install himself on the banks of the Volga, in Siberia, the Caucasus, or Central Asia? He would acquire 5-1/2 acres, more or less, it is true, but is it certain that that would bring him more than it would take from him? On the other hand, if the Germans should have their shares administered by agents chosen from among the natives, what complications, what annoyances would arise! The Germans might perhaps get rid of these difficulties by selling their lands. But what price could they command, with 3,600,000,000 acres all put into the market at once? Who would buy it? It is only necessary to look at the facts at close range (besides a mass of difficulties we have not spoken of) to comprehend that the direct appropriation of the territory of one great modern nation by individuals of another does not enter into the domain of realizable things.

The appropriation of the landed properties is therefore chimerical. The confiscation of personal goods to the profit of the conquerors also offers insurmountable difficulties. There remain the public riches. Few countries could pay indemnities of 5,000,000,000 francs. But even that colossal sum becomes absurdly insufficient when it is equally divided among millions of takers.

All this is most plainly evident, and yet the spirit of conquest and the fatuous idolatry of square miles are more active than ever in the old world of Europe.

Let us see now what this mad aberration costs. We will begin with the direct losses.

A whole continent of our globe, twice as large as the European continent, having 8,000,000 square miles and 80,000,000 inhabitants—North America—is divided into three political dominions: Canada, the United States, and Mexico. As none of these countries covets the territory of the other, there are on this vast continent only 114,453 soldiers and marines, one military man for 700 inhabitants, while in Europe there is one for 108. The American proportion would give 514,286 men for all the European armies. As there are no savage elements in Europe to be restrained by arms, half of the North American contingent ought to be enough to maintain internal order there. Europe needs only 300,000 soldiers at most; all the others are supported in [Pg 524] deference to the idolatry for square miles. This additional military force exceeds 3,300,000 men, and costs 4,508,000,000 francs ($901,600,000) a year. And this is the direct loss entailed by the spirit of conquest; and yet it is trifling as compared with the indirect losses.

First, there are 3,300,000 men under the flags. If they were not soldiers, and were following lucrative occupations and earning only 1,000 francs ($200) a head, they might produce $760,000,000. The $900,000,000 absorbed now by military expenditures would bring five per cent if invested in agricultural and industrial enterprises. This would make another $45,000,000. The twenty-eight days of the reserves are worth at least $40,000,000. Here, then, is an absolutely palpable sum of $845,000,000. But what a number of colossal losses escape all valuation! Capital produces capital. If $1,800,000,000 were saved every year from military expenses and poured into industrial enterprises, they would produce benefits beyond our power to estimate.

To obtain a correct appreciation of the evils derived from the spirit of conquest, we must take a glance at the past. We need not go back of the middle ages, from which we shall only take a few examples. The destruction of wealth wrought by war has been nowhere so frightful as in Spain. In 1073 the Castilians tried to capture Toledo from the Moors. With the military engines of the time it was impossible to accomplish the purpose by a direct attack on a place so admirably fortified by Nature and man; so the King of Castile, Alfonso VI, ravaged the country for three successive years, destroyed the crops, harassed the people and the cattle, and, in short, made a desert around the old capital of the Visigoths.

From 1110 till 1815—seven hundred and five years—there were two hundred and seventy-two years of war between France and England. Now the two nations have lived in peace for eighty years, and it has not prevented them from prospering. What better proof could we have that all the previous wars were useless?

We need not speak of the massacres of the Thirty Years' War, by which a third of the population of Germany perished, or of the frightful hecatombs of Napoleon I, for these facts are in everybody's memory. We shall confine our attention to the losses caused by the spirit of conquest, at least since the Thirty Years' War. Here, again, we shall proceed by analogies. From 1700 to 1815 England expended 175,000,000 francs ($35,000,000) a year for war. Suppose that the expenditures of the other great powers—Germany (including Prussia), Austria, Spain, France, and Russia—were similar. This would make, without counting the smaller states, 1,050,000,000 francs ($210,000,000) for all Europe. Still, as war was not so costly to Russia or Prussia as to [Pg 525] England, we will reduce this figure one fourth. We shall then have, between 1700 and 1815, an annual expenditure of 787,500,000 francs ($157,500,000).[24] Let us estimate the cost of the wars of the seventeenth century at a slightly lower sum, putting it at only 500,000,000 francs (or $100,000,000) a year for all Europe. That would make 41,000,000,000 francs ($8,200,000,000), or for the entire period from 1618 to 1815, 131,562,500,000 francs ($26,312,500,000).

We have more certain data for the nineteenth century. The Crimean, Italian, Schleswig-Holstein, and American Wars, and the war of 1866, cost 46,830,000,000 francs ($9,366,000,000).[25] The war of France cost 15,000,000,000 francs ($3,000,000,000) at the lowest; that of 1877 at least 4,000,000,000 francs ($800,000,000). Add for the war of Greek independence, the French and Austrian expeditions to Spain and Naples, the Polish war of 1830, the Turco-Russian war of 1828-'29, and the wars of 1848, 3,000,000,000 francs ($600,000,000) more—a very moderate estimate; we reach a total sum of 68,830,000,000 francs ($13,766,000,000). None of the extra-European conflicts are comprised in this figure; neither the war between Russia and Persia in 1827, that of Mehemet Ali against the Turks, the struggle against the mountaineers of the Caucasus and against the Arabs in Algeria, or the English campaign in Afghanistan—concerning all of which we have no figures.

Counting only the figures we have been able to obtain, we have for the period from 1618 till our own days 200,392,000,000 francs ($50,078,500,000) as the bare direct losses by war, which have had to be defrayed by the budgets of the different European states. How shall we calculate the indirect losses? Between 1618 and 1648 Germany lost 6,000,000 inhabitants. The destruction of property was prodigious, the ravages were frightful. How can we represent them in money? It is absolutely impossible. There are, too, some expenses arising from the spirit of conquest that almost wholly escape observation. We shall give only two examples of them.

The ctesohedonic fallacy (lust for possession) raged in the middle ages between the nearest neighbors. No city could offer any security unless it was surrounded by strong walls. Since these required great expenditures, they could not be rebuilt every few days. For this reason space was greatly economized in the cities, and their streets were very narrow. At a later period, when security had become established, the walls were demolished. In our own time the needs of [Pg 526] hygiene and luxury have urged the opening of broad ways in the ancient European cities. It has been necessary to buy houses and demolish them in order to create the grand modern avenues. There would have been no walls in the middle ages except for the spirit of conquest, and the broad streets would have been established then, as has been done in the new cities of Russia and America. To pierce these new avenues, Paris, for example, has had to contract debts, the annual interest on which amounts to at least 50,000,000 or 60,000,000 francs ($10,000,000 to $12,000,000). This expense should be charged to the account of the spirit of conquest. But nobody has ever thought of attributing these 50,000,000 or 60,000,000 of the city budget to military waste. And how many other cities are in the same situation? Another example: during six centuries France and England were trying to take provinces from one another. Hence a permanent hostility existed between the two nations. Later on the circumstances changed, but by virtue of the routine inherent in the human mind the old resentments remained, though the motive for them had gone. To thwart the progress of France was considered a patriotic duty by such English ministers as Lord Palmerston. In 1855 M. de Lesseps formed a company to construct the Suez Canal. As M. de Lesseps was a Frenchman, Lord Palmerston and the British Cabinet thought themselves obligated to oppose his project, and their opposition cost about 200,000,000 francs ($40,000,000). The canal might have been constructed then for that sum, but in consequence of the machinations of the English it cost 400,000,000 francs ($80,000,000). Who has ever thought of charging that loss to the account of the spirit of conquest? Nevertheless, that is where it belongs.[26]

The indirect losses of war defy valuation. But the matter may be looked at from another point of view: that of the profits which they prevent being made. The American war against secession cost the treasury of both combatants $7,000,000,000. Now, if, without speaking of the destruction of property,[27] we only consider the benefits nonrealized, the most moderate estimates make them [Pg 527] $12,000,000,000 for the year 1890,[28] and the figure goes on every year increasing in geometrical progression.

Further, the debts must be considered. The largest proportion of them are consequences of the idolatry for square miles. This entails an annual expenditure of $644,800,000 which we should not have to bear were it not for the ctesohedonic fallacy.[29]

Yet another factor has so far not been mentioned: men. The wars of the last three centuries have cost, at the lowest figure, 30,000,000 or 40,000,000 victims. Some authors raise this very moderate estimate to 20,000,000 per century. Without speaking of the frightful sufferings of these unfortunates, they represent an enormous capital.[30] Let us add, further, that these men, if they had not been killed, might have had children that now have no existence. Without the wars of Napoleon I and Napoleon III Europe would have had 45,000,000 more inhabitants than it has, and they might have been producing $2,700,000 a year.[31]

We hope the reader will admit, after these considerations, that the indirect losses of war certainly exceed the direct ones. Still, adhering to our method of underrating rather than exaggerating, we will regard them as equal. We may therefore affirm that the spirit of conquest has cost, since 1618, in the group of European nations alone, the trifle of $80,156,800,000. Suppose we should go farther back—into antiquity even? Imagination refuses to set down the gigantic sums.

This is not all; the cost of civil wars has to be counted, for the conquest of power within the state is attended by massacres which are often not inferior to those of foreign ones. The chiefs of the Roman legions contending for the empire carried on as bloody and costly campaigns against their rivals as against the Parthians or the Germans. The war between Paris and Versailles in 1871 occasioned considerable expenditures, not to speak of the indirect losses, which were immense. [Pg 528] We are, unfortunately, absolutely without data concerning the cost of civil wars, and shall have to satisfy ourselves with what we have been able to obtain concerning foreign wars. $80,156,800,000 used up in two centuries! We need not go outside of this for a solution of the social question. Without this unrestricted waste the earth would now have ten times more wheat, sugar, linen, cotton, meat, wool, etc.; there would be ten times as many houses on the globe, and they would be more spacious, better warmed, and better ventilated; a network of roads, with frequent mails, would cover Europe, Asia, Africa, and America. In short, if conquest had been considered an evil, even during only two centuries, our wealth would have been infinitely superior to what we now possess. But if the ctesohedonic fallacy had been seen through by the civilized societies of the Roman period, the face of the earth would have been very different from what it is. Our planet would have been completely appropriated to the satisfaction of our wants. Waste lands would have been tilled and swamps dried; everywhere that a drop of water could be made to serve for irrigation it would have been applied to that use. Magnificent cities, inhabited by active and industrious populations, would have arisen in numerous places where now are found only briers and stones. In short, we should have been able to see men now, in the year of grace 1894, as we expect to see them in three or four thousand years.

The past can not be changed. We have laid bare the unhappy consequences of our ancient errors simply in order to show how we can assure our welfare in the future. As long as the spirit of conquest rages among men, misery will be the lot of our species. Our savage and barbarous ancestors did not know what we know. Attila, Tamerlane, and even Matabele, a chief of our own times, might be excused for fancying that conquest increases the wealth of the conquerors; but a Moltke and a Prince Bismarck can not. The masses are still too deeply imbued with military vainglory. Happily, they are beginning to open their eyes.—*Translated for the Popular Science Monthly from the book Les Gaspillages des Sociétés Modernes* (The Wastes of Modern Societies), Paris, 1894.

Until within a few years the field for the study of glaciers and their action has been the Alps; but now, as Prof. H.L. Fairchild said in his address as chairman of the Geological Section of the American Association, the North American continent is recognized as a field of the greatest activity, both in the past and at the present time; and, moreover, it presents types of glaciers not known in Europe. It must therefore become the Mecca of foreign students of glaciers.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.[32]

By J. NORMAN LOCKYER, K.C.B., F.R.S.

II.

I must come back from this excursion to call your attention to the year 1845, in which one of the germs of our college first saw the light.

What was the condition of England in 1845? Her universities had degenerated into *hauts lycées*. With regard to the university teaching, I may state that even as late as the late fifties a senior wrangler—I had the story from himself—came to London from Cambridge expressly to walk about the streets to study crystals, prisms, and the like in the optician's windows. Of laboratories in the universities there were none; of science teaching in the schools there was none; there was no organization for training science teachers.

If an artisan wished to improve his knowledge he had only the moribund Mechanics' Institutes to fall back upon.

The nation which then was renowned for its utilization of waste material products allowed its mental products to remain undeveloped.

There was no minister of instruction, no councilors with a knowledge of the national scientific needs, no organized secondary or primary instruction. We lacked then everything that Germany had equipped herself with in the matter of scientific industries.

Did this matter? Was it more than a mere abstract question of a want of perfection?

It mattered very much! From all quarters came the cry that the national industries were being undermined in consequence of the more complete application of scientific methods to those of other countries.

The chemical industries were the first to feel this, and because England was then the seat of most of the large chemical works.[33]

Very few chemists were employed in these chemical works. There were in cases some so-called chemists at about bricklayer's wages—not much of an inducement to study chemistry; even if there had been practical laboratories, where it could have been properly learned. Hence, when efficient men were wanted they were got from abroad—i.e., from Germany, or the richer English had to go abroad themselves.

At this time we had, fortunately for us, in England, in very high place, a German fully educated by all that could be learned at one of the best-equipped modern German universities, where he studied both science and the fine arts. I refer to the Prince Consort. From that year to his death he was the fountain of our English educational renaissance, drawing to himself men like Playfair, Clark, and De la Beche; knowing what we lacked, he threw himself into the breach. This college is one of the many things the nation owes to him. His service to his adopted country, and the value of the institutions he helped to inaugurate, are by no means even yet fully recognized, because those from whom national recognition full and ample should have come, were, and to a great extent still are, the products of the old system of middle-age scholasticism which his clear vision recognized was incapable by itself of coping with the conditions of modern civilized communities.

It was in the year 1845 that the influence of the Prince Consort began to be felt. Those who know most of the conditions of science and art then and now, know best how beneficial that influence was in both directions; my present purpose, however, has only reference to science.

The College of Chemistry was founded in 1845, first as a private institution; the School of Mines was established by the Government in 1851.

In the next year, in the speech from the throne at the opening of Parliament, her Majesty spoke as follows: "The advancement of the fine arts and of practical science will be readily recognized by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you having in view the promotion of these objects, toward which I invite your aid and co-operation."

Strange words these from the lips of an English sovereign!

The Government of this country was made at last to recognize the great factors of a peaceful nation's prosperity, and to reverse a policy which has been as disastrous to us as if they had insisted upon our naval needs being supplied by local effort as they were in Queen Elizabeth's time.

England has practically lost a century; one need not be a prophet to foresee that in another century's time our education and our scientific establishments will be as strongly organized by the British Government as the navy itself.

As a part of the comprehensive scheme referred to by her Majesty, the Department of Science and Art was organized in 1853, and in the amalgamation of the College of Chemistry and the School of Mines we have the germ of our present institution.

But this was not the only science school founded by the Government. The Royal School of Naval Architecture and Marine Engineering was established by the department at the request of the [Pg 531] Lords Commissioners of the Admiralty, "with a view of providing especially for the education of shipbuilding officers for her Majesty's service, and promoting the general study of the science of shipbuilding and naval engineering." It was not limited to persons in the Queen's service, and it was opened on November 1, 1864. The present Royal College of Science was built for it and the College of Chemistry. In 1873 the school was transferred to the Royal Naval College, Greenwich, and this accident enabled the teaching from Jermyn Street to be transferred and proper practical instruction to be given at South Kensington. The Lords of the Admiralty expressed their entire satisfaction with the manner in which the instruction had been carried on at South Kensington; and well they might, for in a memorandum submitted to the Lord President in 1887, the president and council of the Institute of Naval Architects state: "When the department dealt with the highest class of education in naval architecture by assisting in founding and by carrying on the School of Naval Architecture at South Kensington, the success which attended their efforts was phenomenal, the great majority of the rising men in the profession having been educated at that institution."

Here I again point out, both with regard to the School of Mines, the School of Naval Architecture, and the later Normal School, that it was stern need that was in question, as in Egypt in old times.

Of the early history of the college I need say nothing after the addresses of my colleagues, Professors Judd and Roberts-Austen, but I am anxious to refer to some parts of its present organization and their effect on our national educational growth in some directions.

It was after 1870 that our institution gradually began to take its place as a normal school—that is, that the teaching of teachers formed an important part of its organization, because in that year the newly established departments, having found that the great national want then was teachers of science, began to take steps to secure them. Examinations had been inaugurated in 1859, but they were for outsiders, conferring certificates and a money reward on the most competent teachers tested in this way. These examinations were really controlled by our school, for Tyndall, Hofmann, Ramsay, Huxley, and Warington Smyth, the first professors, were also the first examiners.

Very interesting is it to look back at that first year's work, the first cast of the new educational net. After what I have said about the condition of chemistry and the establishment of the College of Chemistry in 1845, you will not be surprised to hear that Dr. Hofmann was the most favored—he had forty-four students.

Professor Huxley found one student to tackle his questions, and he failed. [Pg 532]

Professors Ramsay and Warington Smyth had three each, but the two threes only made five; for both lists were headed by the name of

Judd, John W.,
Wesleyan Training College,
Westminster.

Our present dean was caught in the first haul.

These examinations were continued till 1866, and upward of six hundred teachers obtained certificates, some of them in several subjects.

Having secured the teachers, the next thing the department did was to utilize them. This was done in 1859 by the establishment of the science classes throughout the country, which are, I think, the only part of our educational system which even the Germans envy us. The teaching might go on in schools, attics or cellars, there was neither age limit nor distinction of sex or creed.

Let me insist upon the fact that from the outset practical work was encouraged by payments for apparatus, and that latterly the examinations themselves, in some of the subjects, have been practical.

The number of students under instruction in science classes under examined in the first year in which local examinations were held was 442; the number in 1897 was 202,496. The number of candidates examined in the first year in which local examinations were held was 650, who worked 1,000 papers; in 1897 the number was 106,185, who worked 159,724 papers, chemistry alone sending in 28,891 papers, mathematics 24,764, and physiography 16,879.

The total number of individual students under instruction in science classes under the department from 1859 to 1897 inclusive has been, approximately, 2,000,000. Of these about 900,000 came forward for examination, the total number of papers worked by them being 3,195,170.

Now why have I brought these statistics before you?

Because from 1861 onward the chief rewards of the successful students have been scholarships and exhibitions held in this college; a system adopted in the hope that in this way the numbers of perfectly trained science teachers might be increased, so that the science classes throughout the country might go on from strength to strength.

The royal exhibitions date from 1863, the national scholars from 1884. The free studentships were added later.

The strict connection between the science classes throughout the country and our college will be gathered from the following statement, which refers to the present time: [Pg 533]

Twenty-one royal exhibitions—seven open each year—four to the Royal College of Science, London, and three to the Royal College of Science, Dublin.

Sixty-six national scholarships—twenty-two open each year—tenable, at the option of the holder, at either the Royal College of Science, London, or the Royal College of Science, Dublin.

Eighteen free studentships—six open each year—to the Royal College of Science, London.

A royal exhibition entitles the holder to free admission to lectures and laboratories, and to instruction during the course for the associateship—about three years—in the Royal College of Science, London, or the Royal College of Science, Dublin, with maintenance and traveling allowances.

A national scholarship entitles the holder to free admission to lectures and laboratories and to instruction during the course of the associateship—about three years—at either the Royal College of Science, London, or the Royal College of Science, Dublin, at the option of the holder, with maintenance and traveling allowances.

A free studentship entitles the holder to free admission to the lectures and laboratories and to instruction during the course for the associateship—about three years—in the Royal College of Science, London, but not to any maintenance or traveling allowance.

Besides the above students who have been successful in the examinations of the science classes, a limited number (usually about sixty) of teachers, and of students in science classes who intend to become science teachers, are admitted free for a term or session to the courses of instruction. They may be called upon to pass an entrance examination. Of these, there are two categories—those who come to learn and those who remain to teach; some of the latter may be associates.

Besides all these, those holding Whitworth scholarships—the award of which is decided by the science examinations—can, and some do, spend the year covered by the exhibition at the college.

In this way, then, is the *École Normale* side of our institution built up.

The number of Government students in the college in 1872 was 25; in 1886 it was 113; and in 1897 it was 186.

The total number of students who passed through the college from 1882-'83 to 1896-'97, inclusive, was 4,145. Of these, 1,966 were Government students. The number who obtained the associateship of the Royal School of Mines from 1851 to 1881 was 198, of whom 39 were Government students, and of the Royal College of Science and Royal School of Mines from 1882 [Pg 534] to 1897 the number was 525, of whom 323 were Government students. Of this total of 362 Government students 94 were science teachers in training.

With regard to the Whitworth scholarships, which, like the exhibitions, depend upon success at the yearly examinations throughout the country, I may state that six have held their scholarships at the college for at least a part of the scholarship period, and three others were already associates.

So much for the prizemen we have with us. I next come to the teachers in training who come to us. The number of teachers in training who have passed through the college from 1872 to 1897, inclusive, is about six hundred; on an average they attended about two years each. The number in the session 1872-'73, when they were first admitted, was sixteen, the number in 1885-'86 was fifty, and in 1896-'97 sixty. These have not as a rule taught science classes previously, but before admission they give an undertaking that they intend to teach. In the earlier years some did not carry out this undertaking, doubtless because of the small demand for teachers of science at that time. But we have changed all that. With but very few exceptions, all the teachers so trained now at once begin teaching, and not necessarily in classes under the department. It is worthy of note, too, that many royal exhibitioners and national scholars, although under no obligation to do so, also take up science teaching. It is probable that of all the Government students now who pass out of the college each year not less than three fourths become teachers. The total number of teachers of science engaged in classes under the department alone at the present time is about six thousand.

I have not yet exhausted what our college does for the national efforts in aiding the teaching of science.

When you, gentlemen, leave us about the end of June for your well-earned holidays, a new task falls upon your professors in the shape of summer courses to teachers of science classes brought up by the department from all parts of the four kingdoms to profit by the wealth of apparatus in the college and museum, and the practical work which it alone renders possible.

The number of science teachers who have thus attended the summer courses reaches 6,200, but as many of these have attended more than one course, the number of separate persons is not so large.

Research.—From time to time balances arise in the scholarship fund owing to some of the national scholarships or royal exhibitions being vacated before the full time for which they are tenable has expired. Scholarships are formed from these balances and awarded among those students who, [Pg 535] having completed the full course of training for the associateship, desire to study for another year at the college. *It is understood that the fourth year is to be employed in research in the subject of the associateship.*

The gaining of one of the Remanet scholarships, not more than two on the average annually, referred to, furnishes really the only means by which deserving students are enabled to pursue research in the college; as, although a professor has the power to nominate a student to a free place in his laboratory, very few of the most deserving students are able to avail themselves of the privilege owing to want of means.

The department only very rarely sends students up as teachers in training for research work, but only those who intend making teaching their profession are eligible for these studentships.

I trust that at some future day, when we get our new buildings—it is impossible to do more than we do till we get them—more facilities for research may be provided, and even an extension of time allowed for it if necessary. I see no reason why some of the 1851 exhibition scholarships should not be awarded to students of this college, but to be eligible they must have published a research. Research should naturally form part of the work of the teachers in training who are not brought up here merely to effect an economy in the teaching staff.

Such, then, in brief, are some of our normal-school attributes. I think any one who knows the facts must acknowledge that the organization has justified itself not only by what it has done, but also by the outside activities it has set in motion. It is true that with regard to the system of examining school candidates by means of papers sent down from London, the department was anticipated by the College of Preceptors in 1853, and by Oxford and Cambridge in 1858; but the action of 1861, when science classes open to everybody, was copied by Oxford and Cambridge in 1869. The department's teachers got to work in 1860, but the so-called "University Extension Movement" dates only from 1873, and only quite recently have summer courses been started at Oxford and Cambridge.

The chemical and physical laboratories, small though they were in the department's schools, were in operation long before any practical work in these subjects was done either at Oxford or Cambridge. When the college laboratories began, about 1853, they existed practically alone. From one point of view we should rejoice that they are now third rate. I think it would be wrong of me not to call your attention to the tenacity, the foresight, the skill, the unswerving patience, exhibited by those upon whom has fallen the duty of sailing the good ship "Scientific Instruction," launched, as I have stated, out upon a sea which was certain, from the history I have brought [Pg 536] before you, to be full of opposing currents.

I have had a statement prepared showing what the most distinguished of our old students and of those who have succeeded in the department's examinations are now doing. The statement shows that those who have been responsible for our share in the progress of scientific instruction have no cause to be ashamed.

Conclusion.—I have referred previously to the questions of secondary education and of a true London University, soon, let us hope, to be realized.

Our college will be the first institution to gain from a proper system of secondary education, for the reason that scientific studies gain enormously by the results of literary culture, without which we can neither learn so thoroughly nor teach so effectively as one could wish.

To keep a proper mind-balance, engaged as we are here continuously in scientific thought, literature is essential, as essential as bodily exercise, and if I may be permitted to give you a little advice, I should say organize your athletics as students of the college, and organize your literature as individuals. I do not think you will gain so much by studying scientific books when away from here as you will by reading English and foreign classics, including a large number of works of imagination; and study French and German also in your holidays by taking short trips abroad.

With regard to the university. If it be properly organized, in the light of the latest German experience, with complete science and technical faculties of the highest order, it should certainly insist upon annexing the School of Mines portion of our institution; the past history of the school is so creditable that the new university for its own sake should insist upon such a course. It would be absurd, in the case of a nation which depends so much on mining and metallurgy, if these subjects were not taught in the chief national university, as the University of London must become.

But the London University, like the Paris University, if the little history of science teaching I have given you is of any value, must leave our normal college alone, at all events till we have more than trebled our present supply of science teachers.

But while it would be madness to abolish such an institution as our normal school, and undesirable if not impossible to graft it on the new university, our school, like its elder sister in Paris, should be enabled to gain by each increase in the teaching power of the university. The students on the scientific side of the Paris school, in spite of the fact that their studies and researches are looked after by fourteen professors entitled Maîtres de Conférences, attend certain of the courses at the Sorbonne and the Collége de France, and this is one of the reasons [Pg 537] why many of the men and researches which have enriched French science hail from the *École Normale*.

One word more. As I have pointed out, the French *École Normale* was the result of a revolution; I may now add that France since Sedan has been doing, and in a tremendous fashion, what, as I have told you, Prussia did after Jena. Let us not wait for disastrous defeats, either on the field of battle or of industry, to develop to the utmost our scientific establishments and so take our proper and complete place among the nations.—*Nature.*

THE SERIES METHOD: A COMPARISON.

By CHARLOTTE TAYLOR.

Broadly speaking, there are two methods which are used for the teaching of a language: that of the mother and that of the grammarian. The child learns its own or *mother* tongue from the mother; it learns a foreign tongue from a teacher, whose highest ambition is to be a grammarian. Does the child learn better from the mother or from the grammarian? Without doubt, from the mother, according to the mother method. If this is so, must we use the example of the mother or of the grammarian when we are to begin the teaching of a foreign language? Is there any reason why a foreign tongue should be otherwise taught than the mother tongue? Is it not at least worth the trouble to try the method of the mother, when it is every day demonstrated that pupils who have had five, six, seven years of teaching are unable, on leaving school, so much as to understand when the language they have been studying is used in conversation?

Let us attempt to obtain light on the differences between these two principal methods that exist for teaching a language. What is the mother's method? How does she teach the child to speak? First let us notice that the mother follows the child: she allows him first to show interest in something and then helps him to express *himself*. Here we must pause to notice that what most interests the child is not a thing, an object for itself, but the capacity of the thing to do something, the possibilities of the thing for the performance of an action. A young child takes a thing in its hand and waves it, or strikes it against something, or passes it from one hand to the other; when it is older, it asks invariably, "What for?" The mother names the thing to the child, and also the action that may be therewith performed. The child begins to play. Here a specialty of the mother method comes into view. The mother tells the child that she is *pleased* or *displeased* [Pg 538] with him, that it makes her *happy* or *unhappy* when the child does this or that, that she *thinks* he is a good or a naughty boy, etc.—all of which remarks express her feelings, her thoughts, in contradistinction to the actions which have occasioned these feelings and thoughts; the realm of the mind as opposed to the world of activity. Let us here notice that the speech of every people contains these two classifications of words, the objective and the subjective; and indeed it must be so, since we perform actions and we judge of our actions. By this method the child learns in about a year from the time it begins to speak to express itself about what it does and what it thinks.

Now what is the method of the grammarian? The child learns first the names of things that do not appeal to his consciousness, for they do not start from his point of view, but from that of the maker of a book. He learns lists of words—that is, he learns to know the *symbol*, and not the *thing*; he translates. He learns about Cæsar's wars and the book of his father's uncle in what is called an exercise. For both of these subjects he feels no interest, which is to be expected, as they are abstract. He sees no action. Of the great part of language, which may be called the speech of feeling, he also learns only in the abstract. He reads that Cæsar was glad or that his father's uncle was angry, but the happiness and the anger are outside of his consciousness; they have been presented to him by symbols, that is, printed words. By this method the child learns in about four years to read fairly well; as a rule, speaking the language is entirely out of the question. The pupils can not talk of their actions and their feelings, because these are represented to them by symbols, for such are printed words; they have not grasped them as actualities. If on going into a foreign country they are able to understand what is being said, the teacher may consider himself lucky. He has done his utmost with the method he has chosen to employ. He has attained something. It remains true that the mother accomplishes more in a shorter time than the grammarian.

But is it perhaps possible to put the two methods together, and thus to create a method which shall contain the good of both? We must not continue always to act as the mother does, to teach after her method, or our pupils will continue to talk like a child of two years, and be furthermore unable to write at all. How shall we manage to melt the two into one compact, inseparable whole?

Let us imagine a class is to take its first lesson in the foreign tongue. First, what shall be the matter of the lesson; then, how shall it be presented? We shall be careful to choose a subject that can be interesting to the pupil, hence a subject containing activity. It is not necessary that it [Pg 539] should be anything astonishing or unusual. Let us consider with the pupils how one opens the classroom door. Let us ask the pupil in his mother tongue how he does it, carefully drawing his attention to the number of actions necessary to the accomplishment of our aim, such as walking, standing still, extending the arm, grasping the knob, etc., together with the resulting actions on the part of the door, opening, swinging, etc. We will then draw his attention to the words of activity, the verbs, and tell him he is going to learn those words in the new language—say German. We will now take the first verb necessary to the accomplishment of our aim, that of walking. We will say, *while we walk*, such sentences as "This is gehe," "See how I gehe," "My feet move when I gehe," etc. We do the same with each verb, always with its accompanying action. We will take the first four verbs of our subject, repeat them the first time with many explanatory phrases, the second time with fewer, the third and last time we shall simply repeat the verbs "gehe," "stehe still," "strecke aus," "fasse an," always with the actions. By this time the pupils will know these, they having heard each one at least seven times. We can now allow them to recite, we still giving the clew by the production of the appropriate action. Having taught these first four verbs, we are now ready for the full sentence "I walk toward the door," "I stand still by the door," "I reach out my arm," "I take hold of the knob." We can teach the subject "ich" without difficulty, as it remains the same in all the sentences. Let us take the nouns and teach in this manner: "Ich gehe"—pointing—"Thür," then a repetition of "Thür" contained in sentences describing it, with at least three repetitions of the word. Then come the words showing direction and relation. If you say "Ich gehe"—pointing—"Thür," the pupil will know that there is a word lacking, and he will be unsatisfied till he knows it. We now have a sentence, "Ich gehe nach der Thür." We will teach the other sentences in the same way; we will repeat each sentence at least three times in its entirety, and we will allow the pupils to recite. Here it is of interest to show the pupil that the sentence has sprung from the verb, that the verb is the germ of the sentence. Whether we do this with the words "verb," "sentence," "germ," must depend on the capacity of the class. It is not a question of words, but of ideas. Let us present our subject as a living thing. To supply the pupil with an old-fashioned grammar exercise is like inviting him to make a dinner off papier-maché joints and steaks.

All this time we have been considering the part of language which deals with the *outside* world. It is now time to consider how we shall present the part of language which deals with the inner life. We must make the pupil capable of expressing his states of mind, his thoughts, because these [Pg 540] thoughts are interesting to him. There is, broadly speaking, only one situation in class about which his mind is working: his own success or failure to recite. Hence, before each recitation we shall speak a sentence of encouragement or command, such as "Please begin," "I think you are going to do well." After each recitation we shall speak a sentence of praise or blame, such as "Very good," "It might have been better." These, as they can not be expressed by actions, may be translated when necessary into equivalent phrases in the mother tongue. We shall illustrate each phrase by stories, riddles, quotations, whatever you like. The pupil will be interested, and hence will remember. It is not necessary to the acquisition of knowledge that the pupil should be thoroughly bored while trying to learn. After a sufficient number of repetitions of a phrase by the teacher, it will be handed over to the pupils, who will then address to each other phrases of encouragement, command, praise, blame, etc. We have now enabled the pupil to express an action and his thought; the outside and the inside world are his; he needs only to advance as he began. Each lesson proceeds in this wise:

EXAMPLE.

Part I.—Teacher: "We shall learn about opening the door." General subjective phrase, "Pay attention." Explanation of the phrase through stories.

Teaching of *verbs*.

First subjective phrase before recitation, "Please begin." Explanation through stories.

Recitation.

First subjective phrase after recitation, "Very good." Explanations through stories.

After the teaching of the *sentences*, the subjective phrases are spoken by the pupils.

It lies in the intelligence of the teacher to recognize the moment for introducing phrases.

The lesson then proceeds to the movements of the door as Part II, and to our leaving the door as Part III. The scheme is the same.

All this is a copy (systematized, of course) of the method employed by the mother. Now, first, can the grammarian be useful to us? Let us remember that to begin with his method is to put the cart before the horse. He must play the second but also an important part. The child learns to speak first, but he also learns to read and to write. We will give the same lesson to the pupil in printed form; he will be asked to read it, and then to copy it or write it from dictation. He will receive the new speech through the sense of hearing; it will then be communicated to the sight, and then to the touch. In this manner a class of twenty girls of about thirteen years had been taught English. After about thirty printed lessons had been mastered with the anecdotes, riddles, etc., which had occupied about half a German school year, they were not only able to read and write without many mistakes, but showed a strong desire to express themselves in the new tongue, and were, indeed, able to do so very satisfactorily, as compared with the results obtained by the grammarian after a seven years' course.

Who first thought of combining the two original methods of language teaching in this way? A Frenchman, named François Gouin. He gave it the name of the "Series Method," because each lesson contains a series of actions. After the pupil has learned to express himself in regard to his immediate surroundings he continues to learn in series in regard to the lives of animals and of plants, the processes of housekeeping, traveling, trade, etc. It is all presented simply, but each has its own appropriate words and expressions. As soon as the pupil has mastered the rudiments he will also have the subjective matter presented in a series; in one lesson the teacher will be inclined to mirth, in another to (mock) anger, in another to hope, in another to (mock) despair.

The most important result of education being the evolution of the character already present in the child, let us not consider him a little empty jug to be filled with knowledge; rather let us seek to draw out the riches of his character. When he is able to *live* in a new language, he will be ever broadened, refreshed, and renewed.

This method, resting on a psychological basis, is, with modifications of manner, which it remains the duty of the teacher to recognize, just as good for an adult as for a child. Rules of grammar will be earlier given to the adult, because he will notice correspondences and differences sooner than the child. But no rule will ever be given to a pupil of any age till he himself can appreciate its value, till he is mentally beginning to ask "why?" This questioning state of mind is one highly to be desired, as it is a state of receptivity.

The highest point yet reached by a kite was attained by the leader of a tandem sent up from the Blue Hill Observatory by Messrs. Clayton and Ferguson, August 26th, 12,124 feet above the sea, 277 feet higher than had previously been reached by any kite. The five miles of line weighed seventy-five pounds, and the weight of the whole was one hundred and twelve pounds. With a temperature of 75° and wind velocity thirty-two miles an hour on the ground, the temperature was 38° and the wind velocity thirty-two miles an hour at the highest point reached, while the highest wind velocity recorded was forty miles an hour at 11,000 feet.

THE EARLIEST WRITING IN FRANCE.

By M. GABRIEL DE MORTILLET.

The ancient Celts and Gauls of France had no real letters. A few Celtiberian pieces of money bear characters belonging to the Phœnician and Carthaginian alphabets. In Cisalpine Gaul we find Gallic written in ancient Italian characters. The Greeks, when they founded Massilia and spread themselves along the Mediterranean coast of France, brought their language and writing into the country. The Gauls took advantage of this, and many Gallic inscriptions in Greek characters occur scattered through the south of France, among much more numerous inscriptions in the Greek language and character.

When the Romans came, the Latin alphabet rapidly took the place of the Greek, and the few Gauls that continued faithful to the old tongue used Latin characters in engraving the inscriptions they have left us. Similar changes took place in Gallic pieces of money. Excepting the Celtiberian coins with their Semitic legends and characters, which are found only in a very limited district in the southwest of France, Gallic coins, when they have characters upon them, may be classified as those with Greek and those with Latin legends. The former are very abundant in the south of France, and extend, growing more rare, as we go on into the center and north. Gallic coins with legends in Roman characters gradually become more numerous, and were general after the conquest of Gaul by Julius Cæsar, some of the Gallic populations having only begun to coin money during the earlier period of the Roman occupation.

There are some evidences of the use of a symbolical and hieroglyphical writing before alphabetical writing. On some of the megalithic monuments, principally in Morbihan, stones are found bearing incised engravings, and sometimes sculptures in relief. Are the engravings simply ornamental motives, have they a symbolical meaning, or are they hieroglyphic emblems? Opinions are divided.

The supports of the large and handsome dolmen of the little island of Gavrinis, Morbihan, are filled with engraved lines running into one another and conforming to the shape of the stone or to its composition—all the siliceous and consequently very hard parts being free from them. This indicates a simple ornamentation or decoration executed without any special plan made in advance, according to the nature and form of the stone worked upon. Yet, among the lines of the apparently fanciful ornament a number of polished stone hatchets are very distinctly represented. In all the other dolmens the carvings are much less numerous and not so close. Sometimes they are distributed around, and sometimes they are isolated. Among them we remark [Pg 543] the frequent repetition of some forms in groups or singly, which suggest the thought of signs with a determined sense. Upon a large support of the dolmen of the Petit-Mont at Arzan (Morbihan) there are at the lower left hand three crosses, a sign of frequent occurrence on the megalithic carvings. Above these are two very wide open U's. Seidler sees in these signs letters of the Libyan alphabet, the cross corresponding to C, and the other sign to M. Some persons have further thought they could distinguish an Egyptian letter in the cross. Taking a more general view of the question, Letourneau[34] has tried to prove that the sculptures on the megaliths are inscriptions, and the engraved signs correspond to letters of the ancient alphabets, most probably Semitic. Adrien de Mortillet answered that the thought of writing involved arrangement, and no arrangement could be predicated of the signs.

A short time afterward, Adrien de Mortillet, in a paper on the Figures sculptured on the Megalithic Monuments of France, proved that the figures are more or less rude designs representing a well-determined series of objects. Thus the U's, with branches very widely separated, represent boats, and are emblems of migrations by sea; the crosses are shipmasters' staffs, or insignia of chiefs similar in character to bishops' crosses. The polished hatchet is frequently figured, and often with a handle, and is the emblem of labor, or, more probably, of combat. The scutcheons, which are also frequent, are bucklers, or military symbols. They are usually adorned on the inner side with a variety of symbolical figures variously grouped, which evidently served as the owner's coat of arms, and are the most ancient known specimens of the kind, going back to the stone age, or at least to the transition age from stone to bronze. After that time the custom of putting their owners' arms upon bucklers spread widely. It lasted till the end of the middle ages. The painted vases of classical antiquity furnish numerous and very curious examples of such marks. The interpretation of the megalithic sculptures may furnish probable if not certain details concerning an epoch which is very little known to us. Thus, the scutcheon of the dolmen *des Marchands*, containing four series of crosses, one above the other, and each series divided into two parts, fifty-six crosses in all, may have been the arms of a chief of a powerful confederation having fifty-six less important chiefs under his orders. The supposition is confirmed by the dimensions of the monument and a large handled hatchet engraved under the tablet between two other crosses.

Near the dolmen *des Marchands*, and not far from the sea, is the large tumulus of Marie-Hroeck, [Pg 544] which includes a small dolmen containing rich funerary furnishings. In front of the entrance to the cavern is a rectangular slab that bears on its face a scutcheon containing two crosses, symbolical of power, and several very rudely drawn representations of boats. The engravers of this period were not artists, but stone-cutters, working upon a very hard rock with very poor tools. Unable to figure distinctly what they wanted to, they did the best they could. Handled hatchets were distributed irregularly all round the scutcheons. Does not this epitaph seem to mean that the tomb was erected in memory of a powerful maritime chief by soldiers, his companions in arms?

From these bucklers we pass to generalized feminine representations characterized by concentric necklaces and pairs of prominent globular breasts. Such sculptures, which are repeated in various dolmens and artificial mortuary caves in the valley of the Seine, may be of religious import. They seem to be replaced in the south of France by attempts at statues. Of such character are the two sculptures of the dolmen of Collorgues in Gard, which also have the symbolical cross on their breasts.

Whatever they may be, the megalithic engravings are the earliest graphic historical documents of the country. It is therefore important to collect and preserve them.

They may be divided into simple ornamental motives, which may further suggest interesting resemblances; figurative engravings representing known and definite objects and forming commemorative pictures capable of affording important historical or legendary hints—the most ancient documents in our archives; and symbolical engravings of more difficult determination, and independent of any alphabet.

Among the specimens of the last class, one sort, the cupule, is extremely widespread. It is a very regularly shaped hemispherical cup, generally represented by itself, but sometimes mingled with other figures, most usually occurring in groups without arrangement, but very rarely isolated. Entire surfaces are sometimes covered with this design. It is a very ancient design, as such cupules are found on the dolmens. In the dolmen of Kériaval, at Locmariquer, the lower side of the horizontal slab is starred with numerous cupules, which antedate the construction of the monument, for they appear on the parts that rest on the supports. There may also, however, be more recent cupules. We are totally in the dark as to what they represent.

Cupules are sometimes cut on the surface of rocks in place. Engravings similarly cut have been designated sculptures on rocks, and are found almost everywhere. Those which have been most studied and afford the most features of interest for us are on the Scandinavian coasts, and these [Pg 545] have been largely utilized by Adrien de Mortillet for the determination of the figures of megaliths. We cite only one example from Gaul, the sculptures in the rocks of the Lago dei Maraviglie, in a lateral valley on the left, going from San Dalmazo to Tende, in Piedmont. Some of the walls of the rock there and large surfaces of detached blocks are covered with extremely rude figures formed by the accumulation of dints resulting from frequently repeated blows. Among these figures, which are without order in the grouping, and in which no regard is paid to proportions, are stags, rams, human figurines, hatchets, pikes, baskets, and lance points. These sculptures have been ascribed to the neolithic or the bronze age; but the existence of figures of similar style on the walls of a lead mine near Valauri has suggested that they may be more recent. Human figurines are numerous, but heads of horned animals are more so. Some are perhaps stags and rams, while bulls and cows are abundant. The shepherds are accustomed to take their herds and keep them for two or three months every year in this valley, which is so lonely and melancholy in aspect that it has been called Vallée d'Enfer, or Hell Valley. It would not be strange if these herdsmen, for want of something better to do, should have amused themselves delineating the things that were before their eyes—the cattle, the miners, and things appertaining to the mine. As to special traits, the representations are so badly executed as to leave a wide range open for interpretation.—*Translated for the Popular Science Monthly from the Book Formation de la Nation française* (Paris: Félix Alcan).

An old Newcomen steam engine at North Ashton, near Bristol, England, as described by Mr. W.H. Pearson in the British Association, is still doing practical work after an active career of nearly one hundred and fifty years, it having been erected in 1750 at a cost of seventy pounds. The piston is packed with rope, and has a covering of water on the top to make it steam tight. The working of the engine is aided by the vacuum formed by the injection of water into the cylinder. The old man now engaged in working this engine has held his post since he was a lad, and his father and grandfather occupied the same position.

The excavation of the Roman town of Calleva Attrebatum at Silchester, near Reading, England, has brought to light nearly forty complete houses, a private bathing establishment, two square temples, the west gate, a Christian church possibly of the fourth century, a basilica and forum, an extensive system of dye works, a series of drains, other works, and a multitude of ornaments and utensils—remains of Roman civic life and institutions, complementing previous discoveries of Roman monuments in England, which have been mostly military.

SKETCH OF GABRIEL DE MORTILLET.

"The École d'Anthropologie feels with a profound emotion the loss of the eminent master, one of its glories, whose labors have contributed in so large a measure to honor and magnify it, and to extend and confirm its legitimate authority, and who had the exceedingly rare merit of constituting a science which by means of him has become a French science—that of prehistoric archæology." Such is the eminently fitting tribute spoken by the professors of the Paris École d'Anthropologie through their *Revue Mensuelle* to the memory of Gabriel de Mortillet.

Louis Laurent Gabriel de Mortillet was born at Meylan, Isère, France, August 29, 1821, and died September 25, 1898. He began his studies with the Jesuits at Chambéry, and continued them in Paris at the Museum of Natural History and at the Conservatoire des Arts et Métiers. He was interested in the revolutionary movements of 1848; and in the insurrectionary demonstration of the 13th of June, 1849, which followed the presentation by Ledru Rollin, on the 11th, of a resolution of impeachment against President Louis Napoleon for repressing the republican movement in Rome, it was with his help that the eminent deputy was enabled to escape arrest. In the same year he was condemned for a press offense and took refuge in Savoy. During his exile he classified the collections of the Natural History Museum in Geneva; had charge of the arrangement of the Museum at Annecy in 1854; directed an exploitation of hydraulic lime in Italy; and served as geological adviser in the construction of the northern railways of that country. He was also associated with Agassiz in his studies of the glaciers of Switzerland. He returned to Paris in 1864, and in 1867 was charged with the organization of the first hall or prehistoric department of the History of Labor at the Universal Exposition of 1867. In 1868 he was called to the Museum of National Antiquities at Saint-Germain-en-Laye, where he continued till 1885. It is specially mentioned that he carried this institution safely through the perils of the war of 1870-'71. While engaged in these museum tasks he was struck with the insufficiency of the then universally accepted paleontological and prehistoric classifications, and his attention became fully absorbed in the subject. He held long consultations with Edouard Lartet, the eminent paleontologist and his learned friends concerning it. As a result of these deliberations, after careful study of the formations and specimens, he proposed a scheme of classification in 1869, which was completed at the congress held in Brussels in 1872, and has become generally accepted in its fundamentals, after having withstood the often-repeated attacks of persistent criticism, and has received confirmation after confirmation from innumerable discoveries made throughout the world. "Had his activity concerned only the classification of the different stone ages," says Dr. Capitan, whose eulogy of M. de Mortillet we follow most largely in our sketch, "de Mortillet would for that work alone have been by good right considered a great man of science. Actually to illuminate a number of dark points, to group a thousand scattered facts in regular order, to synthesize numerous isolated researches, to constitute a cohesive theory of them—that is what de Mortillet did. Thus he became long ago the uncontested master, the leader of a school, who was able to group and hold around him the scientific students and workers of the entire world."

M. de Mortillet was in 1866 one of the founders of the International Congress of Prehistoric Archæology. He was one of the first professors in the École d'Anthropologie founded by Broca in 1875, the greatest achievement, as he writes in the preface to his *Formation de la Nation française*, of the Association for the Teaching of Anthropological Sciences. The school was opened in November, 1875, in a building gratuitously lent it by the École de Médecine, to give instruction free of tuition charges, and was to be maintained by a fund subscribed by anthropological societies and private persons, a gift of fifteen hundred dollars a year by M. Wallon for laboratory purposes, and a grant of twenty-five hundred dollars from the Municipal Council of Paris for the payment of professors' salaries. Five courses of lectures were to be delivered, to be increased as the resources of the association multiplied. The association and the school were recognized as of public utility by a law of 1889; the school being the first establishment of private instruction, Dr. Capitan said in his memorial address, "and up to this time (1897) the only one that has had that honor, an honor that creates duties for us. We are under obligation to clarify and extend our teaching." De Mortillet's work was so true to the sentiment expressed in this sentence that one of the characteristics attributed to him in the short biography published in Vaporeau's *Dictionnaire Universel des Contemporains* is that he was one of the men who contributed most to the popularizing of prehistoric studies in France. During the more than twenty years of his professorship of prehistoric anthropology in the École, de Mortillet "gave precious instruction to numerous students, many of whom, foreigners, have in their turns become masters in their own countries." He was also president of the Society of Anthropology, subdirector of the École d'Anthropologie, president of the Association for Teaching Anthropological Sciences, and president of the Commission on Megalithic Monuments—the various functions of which offices he filled with remarkable exactness and distinction. "In all [Pg 548] these important positions," says Dr. Capitan in his eulogy, "de Mortillet unfailingly brought a uniform ardor to his work, a uniform activity, a clear and acute wit, and a remarkable precision. He performed his numerous duties almost to the end of his life. Only last month (July, 1898) he made another journey for the execution of a mission which the commission on megalithic monuments had intrusted to him."

In connection with these multifarious labors, M. de Mortillet published a considerable number of memoirs and of books of the highest order. He was a transformist from the very first, and performed all his various researches in the spirit of an evolutionist. His first publications were on conchology, and numerous memoirs between 1851 and 1862 related to subjects in that branch. During the same period he contributed many important works on the geology and mineralogy of Savoy. Among these were the History of the Land and Fresh-water Mollusks of Savoy and the Basin of Lake Leman, and a Guide to the Traveler in Savoy. His attention was afterward more entirely directed to prehistoric archæology and anthropology, and he published in 1866 a curious Study on the Sign of the Cross previous to Christianity. Of this period, too, are his Promenades, or Walks, in the Universal Exposition of 1867, and his Walks in the Museum of Saint-Germain, 1869. He founded, in 1864, the Recueil, or Collection of Materials for the Positive History of Man, which was afterward continued at Toulouse by M.E. Cartailhac. In 1879 he published a work on pottery marks—*Potiérs allobroges, ou les Sigles figulins étudiés par les Méthodes de l'Histoire naturelle*. In 1881, in co-operation with his son, Adrien de Mortillet, as artist, he published a magnificent illustrated work or album, *Le Musée Préhistorique* (The Prehistoric Museum); and in 1883, the volume *Le Préhistorique* (Prehistoric Archæology); two books which have taken rank as master works. A second edition of the *Préhistorique* appeared in 1885, and at the time of his death he was preparing a third, in which he was taking great pains to bring the matter up to the present condition of the science. Another important work was the *Origines de la Chasse et de la Pêche* (Origin of Hunting and Fishing). A considerable number of memoirs by M. de Mortillet appeared in various scientific journals, especially in the two founded by him—*Les Matériaux pour l'Histoire primitive et naturelle de l'Homme*, already mentioned, and *L'Homme*, which was established in 1884.

An epoch in M. de Mortillet's life was marked in 1873, when a discussion took place at the Anthropological Congress, in Lyons, between him and M. Abel Hovelacque concerning the precursors of man. The researches of the two masters had already led them, by a series of [Pg 549] observations and deductions, to regard as certain the geological existence of a being intermediate between man and the monkey, which they called the *Anthropopithecus*, and they were trying to indicate, hypothetically, its leading characteristics.

M. de Mortillet's reasons for believing in the existence of this precursor of man as a definite being were presented in the *Revue d'Anthropologie*, in an article which was translated and published in the Popular Science Monthly for April, 1879. In this paper the author summarized the evidence, already copious, in favor of the existence of Quaternary man, and then took up the question, "Did there exist in the Tertiary age beings sufficiently intelligent to perform a part of the acts which are characteristic of man?" He then reviewed the researches of the Abbé

Bourgeois at Thenay in the light of a collection of fire-marked flints which he had exhibited at the International Congress of Prehistoric Archæology and Anthropology held in Paris in 1867, and deduced from the result that "during the Middle Tertiary there existed a creature, precursor of man, an anthropopithecus, which was acquainted with fire, and could make use of it for splitting flints. It also was able to trim the flint flakes thus produced, and to convert them into tools. This curious and interesting discovery for a long time stood alone, and arguments were even drawn from its isolated position to favor the rejection of it. Fortunately, another French observer, M.J.B. Rames, has found in the vicinity of Aurillac (Cantal), in the strata of the upper part of the Middle Tertiary—here, too, in company with mastodons and dinotheriums, though of more recent species than those of Thenay—flints which also have been redressed intentionally. In this case, however, the flints are no longer split by fire, but by tapping. It is something more than a continuation, it is a development. Among the few specimens exhibited by M. Rames, whose discoveries are quite recent, is one which, had it been found on the surface of the ground, would never have been called in question." The evidence afforded by these flints was confirmed by a collection of flints from the Miocene and the Pliocene of the valley of the Tagus shown by Señor Ribeiro in the same exhibition, a considerable proportion of which bore evidence of intentional chipping.

Bearing upon this point was a chart of the Palæolithic Age in Gaul, drawn up by M. de Mortillet in 1871, and published in the *Bulletin de la Société d'Anthropologie de Paris*—"the only work of the kind extant"—in which were recorded five localities in which occurred supposed traces of man in the Tertiary, forty-one alluvial deposits in the Quaternary yielding human bones and industrial remains, and two hundred and seventy-eight caverns containing Quaternary fauna with traces of prehistoric man.

M. de Mortillet gave in another form his view of the sort of creature the hypothetical anthropopithecus should be in a paper on Tertiary Man, read before the Anthropological Section of the French Association for the Advancement of Science in 1885, when he said the question was not to find whether man already existed in the Tertiary epoch as he exists at the present day. Animals varied from one geological epoch to another, and the higher the animals the greater was the variation. It was to be inferred, therefore, that man would vary more rapidly than the other mammals. The problem was to discover in the Tertiary period an ancestral form of man a predecessor of the man of historical times. There were, he affirmed, unquestionably in the Tertiary strata objects which implied the existence of an intelligent being—animals less intelligent than existing man, but much more intelligent than existing apes. While the skeleton of this ancestral form of man had not yet been discovered, he had made himself known to us in the clearest manner by his works. The general opinion of the meeting after hearing M. de Mortillet's paper is said to have been that there could be no longer any doubt of the existence of the supposed ancestral form of man in the Tertiary period. [Pg 550]

The discovery in Java, announced by Dr. Dubois, in 1896, of fossil remains presenting structural characteristics between those of man and those of the monkey, to which the name *Pithecanthropus erectus* was given, were accepted with hardly a question by M. de Mortillet and his colleagues as confirming his views.

At a banquet given to M. de Mortillet, May 1, 1884, by a number of anthropologists, when his portrait was presented to him, the hall was decorated for the occasion with a life-size picture of an ancient Gaul, executed according to his latest researches. The man was represented as having no hair on his body; with very long arms and very powerful muscles; his feet capable of being used in climbing trees, but with toes not opposable; his jaw strongly prognathous, but not at all equal to that of an anthropoid ape; his breadth strongly compressed laterally and his abdomen prominent; the skin not negroid, but of our present color; and the expression of his face was about as intelligent as that of an Australian.

In his *Le Préhistorique* M. de Mortillet attempted to determine how far distant was the epoch when *Homo sapiens* first appeared on the earth, by estimating the rate of progression of blocks which were carried by former ice fields, as he had observed them in Switzerland with Agassiz. His conclusion was that more than two hundred thousand years had elapsed since that event.

In 1894 M. de Mortillet proposed in the Société d'Anthropologie an important reform in chronology. Pointing out the inconvenience of using several different eras, such as the [Pg 551] Foundation of Rome, the Flight of Mohammed, and the Proclamation of the French Republic, he suggested that ten thousand years before the Christian era be adopted as a general starting point. This would include all Egyptian chronology as known at the present day, and would leave five thousand years at the disposal of future discoverers.

"A spirit always youthful, a man of progress," says Dr. Capitan in his eulogy, "our dear master kept himself fully in the current with all work relating to prehistoric archæology. He knew how to profit by whatever would contribute to perfect his own work. He therefore, on different occasions, modified his classification so as to keep it up to date, realizing that a classification is an admirable instrument of study, which ought to go through the same evolution as the science to which it is applied." This high quality of his mind appears clearly in his last book, published in 1897—*Formation de la Nation française* (Formation of the French Nation). This book comprised the substance of his lectures of the term 1889-'90. In publishing it he disavowed all intention of producing a new history of France. There were enough of these in all shapes and sizes, written in the most varied styles, with diverse tendencies, and from the most different points of view, and there were some most excellent works among them, particularly that of M. Henri Martin, which seemed to him to contain all the historical information known. But all these histories, even that of

Henri Martin, although he had been president of the Anthropological Society of Paris, appeared to M. de Mortillet to be at fault in their starting point. They gave too much place in their beginnings to the legendary and the imaginary, and not enough to natural history and palæethnology. It was M. de Mortillet's purpose to follow an inverse method—to regard direct observation alone; and he would rest only on the impartial and precise discussion of texts and facts. "Texts, documents, and facts," he said, "become more and more rare as we go back in time. I shall collect and examine them with the greatest care in order to make our origins as clear as possible, and to enlarge the scale of our history. I shall appeal in succession to all the sciences of observation, and when I have recourse to the texts, I shall subject them to the closest criticism and the most complete analysis." The texts on which historians had so far relied did not go back far enough. They told of events three thousand or, including the Egyptian hieroglyphic texts, seven thousand years old, but what was this compared with the immense lapse of time during which man has lived, going back into the Quaternary epoch? On this vast period the texts furnish no information. They were, besides, inaccurate, tinged with fable and poetry, with local and personal prejudice and ignorance, even as to the times to which they relate after history is [Pg 552] supposed to have come in. If we want light upon this unrecorded past, we must seek it by the aid of palæethnological data; and anthropology may be very advantageously united with palæethnology to furnish valuable instruction concerning the autochthonic race of France, its development, transformations, customs, and migrations, and the invasions it suffered in the most remote antiquity. "With the aid of these two sciences, both of wholly new origin, we are able to trace the earliest pages of the history of France." The book begins with a review of what the texts afford regarding the earlier peoples of France; then brings forward the evidence yielded by language and the study of the evolution of writing; next presents the results of research respecting the precursors of man, the rise and development of industries, societies, and civilization; and studies the primitive races of perhaps two hundred and thirty thousand or two hundred and forty thousand years ago; their mixture with the other races that came in from abroad and possessed the country; and, finally, the formation of the French population as we now find it.

M. de Mortillet's relations with his pupils and with his country, and his private character, are spoken of in the highest terms. For more than twenty years his lectures at the École d'Anthropologie, treating the most various questions respecting prehistoric times, attracted large and attentive audiences, often including students from abroad, who afterward became masters of the science in their own countries. "He was always ready to receive workers in the science, even the least and humblest, to bestow advice and encouragement upon them, and to give them the benefit of his experience and extensive erudition, and for this his pupils and friends lament him." Against his integrity no suspicion was ever breathed.

In political faith he was always advanced, and ever true to his convictions. He was *maire* of Saint-Germain from 1882 to 1888, and deputy from the department of Seine-et-Oise from 1885 to 1889.

In the observations of the meteoric shower of November 13, 1897, at Harvard College Observatory, one of the meteors appeared, according to the calculations, at the height of 406 miles, and disappeared at the height of 43 miles, and at a distance of 196 miles. Another appeared at a height of 182 miles and disappeared at a height of 48 miles, and a distance of 74 miles. The first meteor was red or orange, or, to Prof. W.H. Pickering, the color of a sodium flame, and the other white. Both penetrated the atmosphere to about the same depth, and both were clearly Leonids. These facts go to show, Professor Pickering thinks, that the difference in color noted is not due to a mere grazing of our atmosphere in some cases, and a correspondingly low temperature, but to an actual difference in the chemical composition of the individual meteors.

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Correspondence.

THE FOUNDATION OF SOCIOLOGY.

Editor Popular Science Monthly:

Sir: May I be permitted a word of comment upon your editorial entitled A Borrowed Foundation, published in the December number of the Popular Science Monthly? Whatever my readers and reviewers may have claimed for me, I myself have never claimed to be the discoverer of "the consciousness of kind." Not only Mr. Spencer, as he and you have shown; not only Hegel, as Professor Caldwell has shown; but also nearly every philosophical writer and psychologist from Plato and Aristotle down to the present time has more or less clearly recognized the phenomenon of "the consciousness of kind," although I do not know that any one but myself has called it by just this phrase. The only claim, then, that I put forward for my own work is that, in a somewhat systematic way, I have attempted to use the consciousness of kind as the postulate of sociology and to interpret more special social phenomena by means of it. In other words, I have used it as a "foundation"; and I am not aware that any other writer on sociology has ever done so. Mr.

Spencer, I feel quite sure, makes no such claim for himself. The passage which he and you have quoted is taken from the Principles of Psychology; it is not repeated in the Principles of Sociology, where, if it had been regarded by Mr. Spencer as a "foundation," it should have been put forward as the major premise of social theory. Passing over the consciousness of kind, Mr. Spencer has chosen to build his system of sociology in part upon other psychological inductions, in part upon a biological analogy. The tables of the Descriptive Sociology are arranged in accordance with the organic conception, and nine and one half chapters of the Inductions of Sociology in the first volume of the Principles of Sociology are formulated in terms of it. Throughout the remaining parts of the Principles, however, sociological phenomena are explained in terms of two closely correlated generalizations that are psychological in character—namely, first, the generalization that "while the fear of the living becomes the root of the political control, the fear of the dead becomes the root of religious control"; and second, the generalization that militancy and industrialism produce opposite effects on mind and character, and, through them, on every form of social organization. The work that Mr. Spencer has done in elaborating these explanations is of inestimable value, but surely it is not an interpretation of society in terms of the consciousness of kind. Is it then quite fair to suggest that the use made of the consciousness of kind in my own work is a borrowed "foundation"?

However you and Mr. Spencer and my own readers may answer this question, I can sincerely subscribe to your affirmation that there is much more in Mr. Spencer's writings than most even of his truest admirers and most diligent readers have ever explored; and I should be sorry to be regarded as behind the foremost in appreciation of the great work which he has accomplished not only for philosophy in general, but especially for that branch of knowledge which has engaged my own interest.

Franklin H. Giddings.
New York, *December 19, 1898*.

Professor Giddings, in his Principles of Sociology, spoke of the "consciousness of kind" as the "new datum which has been hitherto sought without success." Mr. Spencer, on the other hand, showed that this was not a new datum, inasmuch as he had formulated it himself in a work published many years previously. Professor Giddings says that the passage to which Mr. Spencer referred occurred in his Principles of Psychology, and not in his Principles of Sociology, where, "if it had been regarded by Mr. Spencer as a foundation, it should have been put forward as the major premise of social theory." But Professor Giddings surely does not forget that Mr. Spencer, in laying out his system of synthetic philosophy, made the whole of psychology the basis of, and immediate preparation for, sociology. Quite naturally a writer who is dealing with sociology separately, and not as part of a philosophical system, will find it necessary in laying his foundations to fall back on data furnished by the immediately underlying science; and this explains why Professor Giddings makes use in his Principles of Sociology of a datum which, whether drawn from Mr. Spencer's Psychology or not, was at least to be found there very distinctly expressed. Mr. Spencer himself says that he regarded it as a "primary datum," and calls attention to the fact that he devoted "a dozen pages to tracing the development of sympathy as a result of gregariousness." We are quite prepared to recognize the valuable use which Professor Giddings has made of the doctrine in question, and to admit that, by the extensive development he has given to it, he has imparted a special character and a special interest both to his Principles of Sociology and to his Elements of Sociology noticed elsewhere.—Ed. P.S.M.

EVOLUTION AND EDUCATION AGAIN.

Editor Popular Science Monthly:

Sir: I have not before this acknowledged your reference to me in a spirited and instructive editorial that appeared in the December number of your excellent magazine, because an immediate reply might have been taken to indicate a desire, on my part, for a controversy, which I expressly disclaim; and besides, I have desired that the public might read and consider your views dispassionately. I care but little for the effect upon myself, if the cause of truth shall be materially strengthened.

I am not surprised that you refer to me as "ignorant," "negligible," etc., because it has for a long time been painfully clear that the "scientific mind" is exceedingly sensitive, and while much given to praising forbearance and kindness, still resorts to language reasonably regarded as abusive. I have always found this to be true, and the present controversy is no exception to the rule. The "broadly scientific mind" is, alas! too often narrow and intolerant in treating opposing views. I do not wish, however, to find fault with the abuse—it may prove to be good discipline, and is, therefore, thankfully accepted; but I do very much desire to correct a mistaken inference that you drew from my reference to Herbert Spencer. There are some typographical errors in the quotations that you make, which, however, do not change the meaning. Allow me then to say that I have a great regard for Mr. Spencer; that I have read his writings with much profit, and that I have never failed to accord him full credit for the work he has accomplished. That I can not understand and accept all his teachings does not lessen my respect for him.

At the time that I made my informal talk to the teachers of this city, I had no thought that my remarks would be published or would excite public criticism, or that I would be honored with so distinguished, so critical an audience, or I should have been more careful in the use of terms; but it does seem to me that there is no excuse for the distorted meaning that you and others have given to the quotations. I referred to Mr. Spencer's age to show that we could hope for no change in his philosophy, and the criticism that follows, if it may be styled a criticism at all, is that he has refused to recognize the Deity, and thereby fails to "bless, cheer, and comfort suffering humanity." You discuss it as if I had said that he had not *bettered* the condition of his fellows; but that idea is not in the statement that you quote at all. The word "suffering" was intended to apply to those who, by reason of the misfortunes of this life, are compelled to look beyond themselves and their surroundings for comfort, and who in all ages and among all peoples have turned their thoughts toward a Divine Being for comfort. I merely intended to say, in a very mild and harmless way, that the consolations of a religion based upon a belief in a Divine Providence are necessary for *suffering* humanity, and my immediate reference to Cardinal Newman by way of contrast in almost the same language clearly shows this to be the true meaning of my remarks. The emphasis was on the word "suffering," which was not intended to include more than a fraction of mankind.

I am obliged to you for your reference to Mr. Gladstone, who in his last illness illustrated most fully what I had in my mind. However great his pain, or cheerless the outlook, he continually with serene cheerfulness murmured, "I know that my Redeemer liveth," and "Our Father," etc. It is perhaps unnecessary to add that I am sorry that any one has been led to believe that I underrate the value of the life and work of Herbert Spencer.

Please allow me to refer to the statement in your editorial, "Again dealing with the modern scientific view, that in the development of the human individual all antecedent stages of human development are *in a manner* passed through," etc., in order that I may express my regret that you seem to vitiate the force of the statement altogether by the use of the unscientific phrase "in a manner." The tremendous consequences growing out of the view make serious and exact definition and treatment imperative, and I had hoped that I was entering upon a helpful discussion of it, but was greatly disappointed. I am also unwilling to believe that students of Emerson will be easily convinced that he looked at life "from a stationary point of view," but I do not feel that I can claim your valuable time for a discussion of this point.

May I trust your forbearance in pointing out a manifest misconception in your statement, "We are not imposed upon by childish imitations of mature virtues"? The remark indicates that you have not been brought into immediate association with school children in a schoolroom, at least in recent years.

I refer very reluctantly, but I trust without seeming egotism, to your remarks touching my election to the position which I hold. I am innocent of all responsibility in the matter. I had no "pull" (is the term scientific?). I wrote to the board declining to be a candidate. I refused to allow my friends to speak to the members of the board in my behalf; I preferred the position (Principal of the St. Paul High School) which I had held for years, and I accepted the office with much hesitation; but the intimation that our Board of School Inspectors, composed of business men in every way highly esteemed by the citizens of St. Paul, and deemed worthy of all confidence, had been actuated by unworthy motives, is entirely gratuitous and out of place in a journal such as you would have us believe yours to be. Could there be offered better evidence of haste and unfairness than this uncalled-for assault upon those of whom you know absolutely nothing, and does it not show the scientific inclination to have theory with or without facts, but certainly theory? [Pg 555]

Yours very truly, A.J. Smith,
Superintendent of Schools.
St. Paul, Minn., *January 4, 1899.*

We took the report of Superintendent Smith's address which appeared in the St. Paul papers. If there were any "typographical errors" in our quotations, they were not of our making; and Mr. Smith admits that, such as they were, they did not affect the sense. Well, then, we found Mr. Smith using his position as Superintendent of Schools to disparage a man whom the scientific world holds in the highest honor, and for whom he now tells us he himself has "a great regard"—whose writings he has "read with much profit." We judged the speaker by his own words, and certainly drew an unfavorable inference as to his knowledge and mental breadth. If Mr. Smith did injustice to himself by speaking in an unguarded way, or by not fully expressing his meaning, that was not our fault; and we do not think we can properly be accused of having lapsed into abuse. The explanation he offers of his language regarding Mr. Spencer is wholly unsatisfactory. He gave his hearers to understand that there was an "old man" in London who had devoted all his energies to creating a system of thought which should entirely ignore the name of the Deity, and of whom, after his death, it would not be remembered that he had "ever performed an act or said a word that blessed or comforted or relieved his suffering fellows." The stress, he now says, should be laid on the word "suffering." He did not wish to imply that Mr. Spencer had not bettered the condition of his fellows generally; he only meant that he had done nothing for the *suffering*. On this we have two remarks to make: First, it is not usual, when a man is acknowledged to have given a long lifetime to useful work, to hold him up to reprobation because he is not known to have had a special mission to the "suffering"; and, second, that no man can be of service to mankind at large without being of benefit to the suffering. It is mainly because Mr. Spencer believes so strongly in the broad virtues of justice and humanity, has so unbounded a faith in the efficacy of what may be called a sound social hygiene, that he has had, comparatively, so little to say upon the topics which most interest those who apply themselves specifically, but not always wisely, to alleviating the miseries and distresses of humanity.

As to the means by which Mr. Smith obtained his present position, we know nothing beyond what he now tells us. We saw his appointment criticised as an unsuitable one in the St. Paul papers; and his published remarks seemed to justify the criticism. There are "pulls"—the word is "scientific" enough for our purpose—even in school matters; and it seemed that this was just such a case as a "pull" would most naturally explain. We quite accept, however, Superintendent Smith's statement as to the facts; and we sincerely trust that the next address he delivers to his teachers will better justify his appointment than did the one on which we felt it a duty to comment.

EMERSON AND EVOLUTION.

Editor Popular Science Monthly:

Sir: The editorial in the December Popular Science Monthly on the relations of Emerson to evolution must have surprised many of the students of Emerson. A little over two years ago Moncure D. Conway pointed out (Open Court, 1896) that soon after his resignation from the pulpit of the Unitarian Church with which he was last connected, Emerson taught zoölogy, botany, paleontology, and geology, and that he was a pronounced evolutionist who used in his lectures the argument in favor of evolution drawn from the practical identity of the extremities of the vertebrates. That Emerson was an evolutionist of the Goethean type is clear from most of his essays. In an essay appearing before the Origin of Species, he wrote as follows:

"The electric word pronounced by John Hunter a hundred years ago, *arrested and progressive development*, indicating the way upward from the invisible protoplasm to the highest organisms, gave the poetic key to Natural Science, of which the theories of Geoffroy Saint-Hilaire, of Oken, of Goethe, of Agassiz and Owen and Darwin in zoölogy and botany are the fruits—a hint whose power is not exhausted, showing unity and perfect order in physics.

"The hardest chemist, the severest analyzer, scornful of all but the driest fact, is forced to keep the poetic curve of Nature, and his results are like a myth of Theocritus. All multiplicity rushes to be resolved into unity. Anatomy, osteology, exhibit arrested or progressive ascent in each kind; the lower pointing to the higher forms, the higher to the highest, from the fluid in an elastic sac, from radiate, mollusk, articulate, vertebrate, up to man; as if the whole animal world were only a Hunterian museum to exhibit the genesis of mankind."

The Darwin to whom reference is made in this essay is not Charles, but his grandfather, one of the poets of evolution, Erasmus. The essay also shows the belief in evolution held by both Owen and Louis Agassiz before theological timidity made them unprogressive. The names quoted illustrate further the factors which influenced Emerson's thought in regard to evolution. Saint- [Pg 556]
Hilaire gave the *coup de grâce* to Cuvier's fight against evolution. Oken is one of the great pioneers of evolution. Goethe shares with Empedocles, Lucretius, and Erasmus Darwin the great honor of being a poet of evolution. Of the four, Goethe was by all odds the greatest. To him, the doctrine of evolution was of more importance than the downfall of a despot. The eve of the Revolution of 1830 found him watching over the dispute between Cuvier and Saint-Hilaire with an interest that obscured every other.

"'Well,' remarked Goethe to Soret," (Conversations with Eckermann) "'what do you think of this great event? The volcano has burst forth, all in flames, and there are no more negotiations behind closed doors.' 'A dreadful affair,' I answered, 'but what else could be expected under the circumstances, and with such a ministry, except that it would end in the expulsion of the present royal family?' 'We do not seem to understand each other, my dear friend,' replied Goethe. 'I am not speaking of those people at all; I am interested in something very different. I mean the dispute between Cuvier and Geoffroy de Saint-Hilaire, which has broken out in the Academy, and which is of such great importance to science.' This remark of Goethe's came upon me so unexpectedly that I did not know what to say, and my thoughts for some minutes seemed to have come to a complete standstill. 'The affair is of the utmost importance,' he continued, 'and you can not form any idea of what I felt on receiving the news of the meeting on the 19th. In Geoffroy de Saint-Hilaire we have now a mighty ally for a long time to come. But I see also how great the sympathy of the French scientific world must be in this affair, for, in spite of a terrible political excitement, the meeting on the 19th was attended by a full house. The best of it is, however, that the synthetic treatment of Nature introduced into France by Geoffroy Saint-Hilaire can now no longer be stopped. This matter has now become public through the discussion in the Academy carried on in the presence of a large audience; it can no longer be referred to secret committees or be settled or suppressed behind closed doors.'"

It is obvious to any reader of Emerson's essays that Goethe exercised an enormous influence over him, and that Emerson was much more in sympathy with Goethe than was the fetichistic dualist Carlyle. This influence of Goethe over Emerson's views of evolution is clearly evident in the citation already made.

The evolutionary views of Emerson appear so frequently in his essays that it is astonishing that he should have been misunderstood. The citation by the Minneapolis clergyman from the essay on Nature that "man is fallen" does not refer to the Adamic fall, but the degenerating influence of cities. At the slightest glance, the evolutionary tendency of this essay on Nature is evident. In the paragraph immediately after that containing the reference to fallen man occurs the following:

"But taking timely warning and leaving many things unsaid on this topic, let us not longer omit our homage to the efficient Nature, *natura naturans*, the quick cause before which all forms flee as the driven snows, itself secret, its works driven before it in flocks and multitudes (as the ancient represented Nature by Proteus, a shepherd), and in indescribable variety. It published itself in creatures reaching from particles and spicula through transformation on transformation to the highest symmetries, arriving at consummate results without a shock or a leap. A little heat, that is a little motion, is all that differences the bald dazzling white and deadly cold poles of the earth from the prolific tropical climates. All changes pass without violence by reason of the two cardinal conditions of boundless space and boundless time. Geology has initiated us into the secularity of Nature and taught us to disuse our school-dame measure and exchange our Mosaic and Ptolemaic scheme for her large style. We knew nothing rightly for want of perspective. Now we learn what patient ages must round themselves before the rock is broken and the first lichen race has disintegrated the thinnest external plate into soil and opened the door for the remote flora, fauna, Ceres and Pomona to come in. How far off yet is the trilobite, how far the quadruped, how inconceivably remote is man! All duly arrive, and then race after race of men. It is a long way from granite to the oyster; farther yet to Plato and the preaching of the immortality of the soul. Yet all must come, as surely as the first atom has two sides."

It would be useless to multiply citations along this line to demonstrate not only that Emerson was an evolutionist, but that his whole philosophy was pervaded by the doctrine. It should be remembered that, at the time Emerson wrote, evolution had won wide favor among thinkers and that the success of the Origin of Species was an evidence, not of the creation of the evolution sentiment by that work, but of a pre-existing mental current in favor of evolution.

Very respectfully,
Harriet C.B. Alexander.
Chicago, *December 20, 1898.*

Editor's Table.

THE NEW SUPERSTITION.

The death of a prominent man of letters in the hands of certain individuals of the "Christian Science" persuasion has given rise to a good deal of serious discussion as to the principles and practices of that extraordinary sect. That a considerable number of persons should have banded themselves together to ignore medical science, and apply "thought" as a remedy for all physical ills, has excited no little alarm and indignation in various quarters. Some of the severest criticisms of this outbreak of irrationality have come from the religious press, which takes the ground that, while the Bible doubtless contains numerous accounts of miraculous healing, it nevertheless fully recognizes the efficacy of material remedies. A "beloved physician" is credited with the authorship of one of the gospels and of the book of Acts. An apostle recommends a friend to "take a little wine for his stomach's sake and his often infirmities." The man who was attacked by robbers had his wounds treated in the usual way. The soothing effect of ointments is recognized; and the disturbing effects of undue indulgence in the wine cup are forcibly described. The peculiar character of a miracle, it is contended, lies in the fact that it passes over natural agencies; but, because these may be dispensed with by Divine Power, they are not the less specifically efficacious in their own place.

These, and such as these, are the arguments which are urged by the representatives of orthodox religion against the new heresy, or, as we have called it, "the new superstition." To argue against it on scientific grounds would be almost too ridiculous. When people make a denial of the laws of matter the basis of their creed, we can only leave them to work it out with Nature. They will find that, like all the world, they are subject to the law of gravitation and to the laws of chemistry and physics. If one of them happens to be run over by a railway train the usual results will follow; and so of a multitude of conceivable accidents. A Christian Scientist who "blows out the gas" will be asphyxiated just like anybody else; and if he walks off the wharf into the water he will require rescue or resuscitation just as if he were a plain "Christian" or a plain "scientist." Like Shylock, he is "fed with the same food, hurt with the same weapons, subject to the same diseases" as the rest of the community; and little by little the eternal course of things will chastise his extravagant fancies into reasonable accord with facts.

To tell the truth, we have not much apprehension that the health of the community will suffer, or the death rate go up, as the result of this new craze. On the contrary, we rather expect that any influence it may have in these respects will, on the whole, be for the better; and for a very simple reason: The laws of health are not so difficult to master, and, as every adherent of "Christian Science" will be anxious to reflect credit on it by the satisfactory condition of his or her personal health, we quite believe that in the new sect more diseases will be avoided than incurred. Moreover, the elevated condition of mind of these enthusiasts makes in itself for health, so long as it does not turn to hysteria. We certainly can not refuse all sympathy to people who make it a principle to enjoy good health. Of course, if they were thoroughly consistent, they might do mischief in direct proportion to their numbers. A "Christian-Science" school board who did not believe in ventilating or adequately warming school rooms, holding that it made no difference whether the children breathed pure air or air laden with carbon dioxide and ptomaines, or whether or not they were exposed to chills and draughts, would be about as mischievous a body of men as could well be imagined. If "Christian Science" in the house means an indifference to the ordinary physical safeguards of health, it will quickly make a very evil repute for itself. But, as we have already said, we do not anticipate these results. Having undertaken to avoid and to cure diseases by "thinking truth," we believe our friends of the new persuasion will think enough truth to get what benefit is to be got from cleanliness, fresh air, and wholesome food,—and that will be quite a quantity.

EMERSON.

We publish on another page a letter from a correspondent who thinks that much injustice is done to Emerson in the remarks we quoted in our December number from Mr. J.J. Chapman's recent volume of essays. What Mr. Chapman said was, in effect, that Emerson had not placed himself in line with the modern doctrine of evolution—that he was probably "the last great writer to look at life from a stationary standpoint." Mrs. Alexander says in reply that Emerson was an evolutionist before Darwin, having learned the doctrine from Goethe and made it a fundamental principle of his philosophy. No one who has read Mr. Chapman's essay could think for a moment that there was any intention on his part to deal ungenerously or unfairly with the great writer of whom America is so justly proud; nor would many readers be disposed to question his competence to pronounce a sound judgment upon his subject. There must, therefore, it seems to us, be some way of reconciling the verdict of Mr. Chapman with the claims set forth in our correspondent's letter.

The true statement of the case doubtless is that Emerson received the doctrine of evolution—so far as he received it—as a poet. He welcomed the conception of a gradual unfolding of the universe, and a gradually higher development of life; but it dwelt in his mind rather as a poetical imagination than as a scientific theory. The consequence was that he was still able to speak in the old absolute manner of many things which the man of science can only discuss from a relative standpoint. When, for example, Emerson says, "All goes to show that the soul in man is not an organ, but animates and exercises all the organs; is not a function, like the power of memory, of calculation, of comparison, but uses these as hands and feet; is not a faculty, but a light; is not the intellect or the will, but the master of the intellect and the will; is the background of our being in which they lie—an immensity not possessed and that can not be possessed"—he may be uttering the sentence of a divine philosophy, or the deep intuition of a poet; but he is not speaking the language of science, nor evincing any sense of the restrictions which science might place on such expressions of opinion. Certainly he is not at the standpoint of evolution; and it is very hard to believe that the views he announces could in any way be harmonized with, say, Mr. Spencer's Principles of Psychology. Or take such a passage as the following: "All the facts of the animal economy—sex, nutriment, gestation, birth, growth—are symbols of the passage of the world into the soul of man, to suffer there a change and reappear a new and higher fact. He uses forms according to the life, and not according to the form. This is true science. The poet alone knows astronomy, chemistry, vegetation, and animation, for he does not stop at these facts, but employs them as signs. He knows why the plain or meadow of space was strewn with those flowers we call suns and moons and stars; why the great deep is adorned with animals, with men, and gods; for in every word he speaks he rides on them as the horses of thought." Now, we should be sorry to crumple one leaf in the laurel wreath of the poet; but is there much sense in saying that he is our only astronomer, or that he could inform us why suns and planets were disposed through space so as to make the forms we see? We do not think Goethe held these ideas; if he did, they were certainly not part of his evolution philosophy. The doctrine of evolution is not at war, we trust, with poetic inspiration; but if it teaches anything, it teaches that the world is full of infinite detail, and that without a certain mastery of details general views are apt to be more showy than solid. It also brings home to the mind very forcibly that one can only be sure of carefully verified facts, and, even of these, ought not to be too sure. It teaches that time and place and circumstance are, for all practical purposes, of the essence of the things we have to consider; that nothing is just what it would be if differently conditioned. There is nothing of which Emerson discourses with so much positiveness as the soul, an entity of which the serious evolutionist can only speak with all possible reserve. The evolutionist labors to construct a psychology; but Emerson has a psychology ready-made, and scatters its affirmations with a liberal hand through every chapter of his writings. That these are stimulating in a high degree to well-disposed minds we should be sorry to deny. They are a source, which for many long years will not run dry, of high thoughts and noble aspirations. No one has more worthily or loftily discoursed of the value of life than has the New England philosopher; and for this the world owes him a permanent debt of gratitude. But he was not an evolutionist in the modern sense—that is, in the scientific sense. If, as Mr. Chapman says, he was the last great writer to look at life from a stationary standpoint, then we can only add that the old philosophy had a golden sunset in his pages.

Scientific Literature.

SPECIAL BOOKS.

There are a great many different ways of conceiving the science of society, and until the study of the subject is more advanced than it is as yet, it would be rash to set up any one method as superior to all others. All that can reasonably be asked is that the subject should be approached with a competent knowledge of what has previously been thought and written in regard to it, that the aspects presented should possess intrinsic importance, and that the treatment should be scientific. The work which Professor *Giddings* has published under the title of *Elements of Sociology*[35] fulfills these conditions entirely, and we consider it, after careful examination, as admirably adapted to the purpose it is meant to serve—namely, as "a text book for colleges and schools." For use in schools—that is to say, in secondary schools of the ordinary range—the treatment may be a little too elaborate, but for college use we should say that it is, so far as method is concerned, precisely what is wanted. We do not know any other work which gives in the same compass so interesting and satisfactory an analysis of the constitution and development of society, or so many suggestive views as to the springs of social action and the conditions of social well-being. Professor Giddings writes in a clear and vigorous style, and the careful student will notice many passages marked by great felicity of expression. In a text-book designed to attract the young to a subject calling for considerable concentration of attention, this is an advantage that can hardly be overestimated.

In the first chapter the writer gives us his definition of society as "any group or number of individuals who cultivate acquaintance and mental agreement—that is to say, like-mindedness." The unit of investigation in sociology is declared to be the individual member of society, or, as the writer calls him, in relation to the investigation in hand, the "socius." Whether in strict logic the unit of investigation in *sociology* can be the individual, even granting, as must be done, that he is born social, is a point on which we are not fully satisfied. We should be disposed to think that the study of the individual was rather what Mr. Spencer would call a "preparation" for sociology than an integral part of the science itself. From a practical point of view, however, it must be conceded that a treatise on sociology would begin somewhat abruptly if it did not present in the first place an adequate description of the "socius," especially setting forth those qualifications and tendencies which fit and impel him to enter into relations with other members of the human race. Chapter V of the present work deals with The Practical Activities of Socii, and shows in an interesting manner what may be called the lines of approach of individuals to one another in society. Sometimes the approach is by means of conflict, and the writer shows how this may be a preparation for peaceful relations through the insight it gives into opposing points of view. He distinguishes between primary and secondary conflict—the first being a struggle in which one individual violently strives to suppress or subdue an opposing personality, the second a mere trial of differing opinions and tastes, leading often to a profitable readjustment of individual standpoints.

Chapter X, entitled The Classes of Socii, is an excellent one. The author classifies socii with reference (1) to vitality, (2) to personality—i.e. personal resource and capacity—and (3) to social feeling. Under the third classification he distinguishes (1) the social class, (2) the non-social class, (3) the pseudo-social class, and (4) the anti-social class. The first of these, the "social class," is well characterized as follows: "Their distinguishing characteristic is a consciousness of kind that is wide in its scope and strong in its intensity. They are sympathetic, friendly, helpful, [Pg 561] and always interested in endeavoring to perfect social relations, to develop the methods of co-operation, to add to the happiness of mankind by improving the forms of social pleasure, to preserve the great social institutions of the family and the state. To this class the entire population turns for help, inspiration, and leadership, for unselfish loyalty and wise enterprise. It includes all who in the true sense of the word are philanthropic, all whose self-sacrifice is directed by sound judgment, all true reformers whose zeal is tempered by common sense and sober patience, and all those who give expression to the ideals and aspirations of the community for a larger and better life." The Pre-eminent Social Class is further discussed in Chapter XII; and the subsequent chapters, as far as, and including, XIX, describe the processes by which social results in the balancing of interests, establishment of rights, assimilation of characters, and general improvement of social conditions, are realized. The limits which expediency sets to the pursuit of "like-mindedness" are well shown, and the advantage and necessity for social progress of free discussion and wide toleration of individual differences are strongly insisted on. Chapter XX deals with The Early History of Society, and contains the statement that "from an apelike creature, no longer perfectly represented in any existing species, the human race is descended."

The subject of Democracy is well treated in a special chapter (XXIV). The author is of opinion that, if the natural leaders of society do their duty, they will wield a moral influence that will give a right direction to public policy, and secure the continuous advance of the community in prosperity and true civilization. The "if" is an important one, but the author has strong hope, in which all his readers will certainly wish to share, that in the main everything will turn out well.

The remarks on the State in Chapter XXIII are, as far as they go, judicious; but we could have wished that the author, who we are sure desires to make his treatise as practically useful as possible, had dwelt somewhat on the dangers of over-legislation, and had brought into fuller relief than he has done the difference between state action and voluntary enterprise, arising from the fact that the former always involves the element of *compulsion*. We pass a law when we can not get our neighbor to co-operate or agree with us in something, and consequently resolve to compel him. Surely this consideration should suffice to make parsimony the first principle of legislation. We agree with our author that it is not well to "belittle" the state (page 214), but it is hardly belittling the state to wish to be very sparing in our appeals to it for the exercise of coercive power.

We miss also in the work before us such a treatment of the *family* as might have been introduced into it with advantage. The family certainly has an important relation to the individual, and in all civilized countries it is specially recognized by the state. Mr. Spencer, in the chapter of his Study of Sociology entitled Preparation in Psychology, has dwelt on the encroachments of the state on the family; and Mr. Pearson, in his National Life and Character, published half a dozen years ago, sounded a note of alarm on the same subject. What position Professor Giddings would have taken as to the importance of family life and the rights and duties of the family we do not, of course, know; but we are disposed to think he could have increased the usefulness and interest of his book by some discussion of these points. We would only further say that, while the book is specially intended for scholastic use, it is well adapted for general reading, and that it could not be read carefully by any one without profit. [Pg 562]

Prof. *Wesley Mills* holds the opinion that in the present stage of the study of animal life,[36] facts are much more desirable than theories. Experiment and observation must go on for many years before generalizations will be worth the making. Putting this belief into practice, he has bred and reared a large number of animals, making most careful notes on their physical and mental development, and furnishes in his book, resulting from these studies, a contribution of unquestionable value to comparative psychology.

In his investigation of the habits of squirrels, he finds the red squirrel, or chickaree, much more intelligent than the chipmunk. The latter is easily trapped, but the former profits by experience and is rarely secured a second time. These little creatures are also adepts in feigning. Two examples are cited in which squirrels apparently ill recovered rapidly when left alone and made their escape in vigorous fashion. Many instances of animals shamming death are judged to be cases of catalepsy induced by excessive fear. The chickaree is also credited with some musical capacity, one being observed, when excited, to utter tones that were birdlike; whence it is concluded "likely that throughout the order *Rodentia* a genuine musical appreciation exists, and considerable ability in expressing states of emotion by vocal forms."

While experimenting with hibernating animals, Professor Mills kept a woodchuck in confinement five years, and noted that it had a drowsy or torpid period from November to April. Another specimen subjected to the same conditions did not hibernate for an hour during the entire season. Bats began to hibernate at 45° to 40° F., and were so affected by temperature that they could be worked like a machine by varying it. The woodchuck, however, was comparatively independent of heat and cold, but very sensitive to storms. This is found to be true of many wild animals, that they "have a delicate perception of meteorological conditions, making them wiser than they know, for they act reflexly."

Some records are given of cases of lethargy among human beings, and in regard to these, as well as normal sleep and hibernation, it is suggested that their conditioning and variability throw great light upon the evolution of function.

In order to observe closely the psychic development of young animals, Professor Mills raised families of dogs, cats, chickens, rabbits, guinea-pigs, and pigeons. The data obtained by him, given in the form of diaries with comparisons and conclusions, constitute Part III, the larger half of the book, unquestionably first in importance and interest. It is scarcely possible to overvalue careful studies like these, undertaken not to justify theories, but to bring to light whatever truths may be apprehended of the nature of growth and connection of mind and body.

The last division of the book contains the discussions on instinct by Professors Mills, Lloyd Morgan, Baldwin, and others, first published in Science. The beginning of the volume, devoted to a general consideration of the subject, consists of papers on methods of study and comparative psychology which have appeared in various scientific periodicals, including this magazine. [Pg 563]

GENERAL NOTICES.

In *Four-Footed Americans and their Kin*[37] a similar method is applied by *Mabel Osgood Wright* to the study of animals to that which was followed with reference to ornithology in Citizen Bird. The subject is taught in the form of a story, with dramatic incident and adventure, and miniature exploration, and the animals are allowed occasionally to converse and express their opinions and feelings. The scene of the action is "Orchard Farm and twenty miles around." Dr. Hunter and his daughter and colored "mammy" have returned there to their home after several years of travel, with two city youths who have been invited to spend the summer at the place and are told the story of the birds. Another family have come to make an autumn visit, but it is arranged that they should spend the winter at the farm. "What they did, and how they became acquainted with the four-footed Americans, is told in this story." Most of the common animals of the United States are met or described in the course of the party's wandering, as creatures of life rather than as in the cold and formal way of treating museum specimens, and a great deal of the lore of other branches of natural history is introduced, as it would naturally come in in such excursions as were taken. The scientific accuracy of the book is assured by the participation of Mr. Frank M. Chapman as editor. At the end a Ladder for climbing the Family Tree of the North American Mammals is furnished in the shape of a table of classification; and an index of English names is given. The illustrations, by Ernest Seton Thompson, give lifelike portraits and attitudes and are very attractive.

St. George Mivart, whose enviable reputation as a specialist in natural history has perhaps given some justification for his attempts at philosophy, has recently published a new philosophical work entitled *The Groundwork of Science*[38]. It is an effort to work out the ultimate facts on which our knowledge, and hence all science, is based. A short preface and introductory chapter are devoted to a statement of the aims of the work and some general remarks regarding the history of the scientific method. An enumeration of the sciences and an indication of some of their logical relations are next given. The third chapter, entitled The Objects of Science, is given up chiefly to a refutation of idealism. The methods of science, its physical, psychical, and intellectual antecedents, language and science, causes of scientific knowledge, and the nature of the groundwork of science are the special topics of the remaining chapters. The general scheme of the inquiry is based on the theory that the groundwork of science consists of three divisions. "The laborers who work, the tools they must employ, and that which constitutes the field of their labor.... Science is partly physical and partly psychical.... The tools are those first principles and universal, necessary, self-evident truths which lie so frequently unnoticed in the human intellect, and which are absolutely indispensable for valid reasoning.... The nature of the workers must also be noticed as necessarily affecting the value of their work.... And, last of all, a few words must be devoted to the question whether there is any and, if any, what foundation underlying the whole groundwork of science." The result at which the author arrives is stated as follows: "The groundwork of science is the work of self-conscious material organisms making use of the marvelous first principles which they possess in exploring all the physical and psychical phenomena of the universe, which sense, intuition, and ratiocination can anyhow reveal to them as real existences, whether actual or only possible.... The foundation of science can only be sought in that reason which evidently to us pervades the universe, and is that by which our [Pg 564]
intellect has been both produced and illumined."

A large amount of information, mainly of a practical character, has been gathered by Mr. *William J. Clark* in his book on *Commercial Cuba*[39]—information, as Mr. Gould well says in the introduction he has contributed to the work, covering almost the entire field of inquiry regarding Cuba and its resources. The data have been partly gained from the author's personal observation and during his travels on the island, and partly through laborious and painstaking classification of existing material, collected from many and diverse sources. The subject is systematically treated. The first chapter—How to Meet the Resident of Cuba—relates to the behavior of visitors to the island, really a considerably more important matter than it would be in this country, for the Spaniards are strict in their regard for correct etiquette. It is natural that a chapter on the population and its characteristics and occupations should follow this. Even more important than correct behavior—to any one at least but a Spaniard—is the subject of climate and the preservation of health; and whatever is of moment in relation to these subjects is given in the chapter devoted to them. Next the geographical characteristics of Cuba are described, and the facilities and methods of transportation and communication; also social and political matters, including government, banking, and commercial finance, and legal and administrative systems of the past and future. A chapter is given to Animal and Vegetable Life, another to Sugar and Tobacco, and a third to Some General Statistics, after which the several provinces—Pinar del Rio, the city and province of Havana (including the Isle of Pines), and the provinces of Matanzas, Santa Clara, Puerto Principe, and Santiago—are described in detail, with their physical characteristics, their agricultural or mining resources, their various towns, and whatever else in them is of interest to the student of economics. A Cuban Business Directory is given in the appendix.

A Collection of Essays is the modest designation which Professors *J.C. Arthur* and *D.T. MacDougal* give to the scientific papers included in their book on *Living Plants and their Properties*.[40] The authors deserve all praise for having taken the pains without which no book composed of occasional pieces can be made complete and symmetrical, to revise and rewrite the articles, omitting parts "less relevant in the present connection," and amplifying others "to meet the demands of continuity, clearness, and harmony with current botanical thought." Of the twelve papers, those on the Special Senses of Plants, Wild Lettuce, Universality of Consciousness and Pain, Two Opposing Factors of Increase, The Right to Live, and Distinction between Plants and Animals, are by Professor Arthur; and those on The Development of Irritability, Mimosa—a Typical Sensitive Plant, The Effect of Cold, Chlorophyll and Growth, Leaves in Spring, Summer, and Autumn, and the Significance of Color, are by Professor MacDougal. Based to a large extent on original investigations or careful studies, they present many novel thoughts and aspects, and constitute an acceptable addition to popular botanical literature.

Having described the great and growing interest taken in child study, President *A.R. Taylor* announces as the principal aim of his book, *The Study of the Child*,[41] to bring the subject within the average comprehension of the teacher and parent. Besides avoiding as much as possible technical terms and scientific formulas, the author has made the desire to announce new principles subservient to that of assisting his fellow-workers to a closer relationship with the child. As teachers and parents generally think it extremely difficult to pursue the study of the child without at least a fair understanding of the elements of psychology, the author intimates [Pg 565]
that they often forget that the study will give them that very knowledge, and that, properly pursued, it is the best possible introduction to psychology in general. Every chapter in the present book, he says, is an attempt to organize the knowledge already possessed by those who know little or nothing of scientific psychology, and to assist them to inquiries which will give a clearer apprehension of the nature and possibilities of the child. The treatise begins with the wakening of the child to conscious life through the senses, the nature and workings of each of

which are described. The bridge over from the physical to the mental is found in consciousness, which for the present purpose is defined as the self knowing its own states or activities. The idea of identity and difference arises, symbols are invented or suggested, and language is made possible. The features of language peculiar to children are considered. Muscular or motor control, the feelings, and the will are treated as phases or factors in development, and their functions are defined. The intellect and its various functions are discussed with considerable fullness; and chapters on The Self, Habit, and Character; Children's Instincts and Plays; Manners and Morals; Normals and Abnormals; and Stages of Growth, Fatigue Point, etc., follow. A very satisfactory bibliography is appended.

The Discharge of Electricity through Gases[42] is an expansion of four lectures given by the author, Prof. *J.J. Thomson*, of the University of Cambridge, at Princeton University in October, 1896. Some results published between the delivery and printing of the lectures are added. The author begins by noticing the contrast between the variety and complexity of electrical phenomena that occur when matter is present in the field with their simplicity when the ether alone is involved; thus the idea of a charge of electricity, which is probably in many classes of phenomena the most prominent idea of all, need not arise, and in fact does not arise, so long as we deal with the ether alone. The questions that occur when we consider the relation between matter and the electrical charge carried by it—such as the state of the matter when carrying the charge, and the effect produced on this state when the sign of the charge is changed—are regarded as among the most important in the whole range of physics. The close connection that exists between chemical and electrical phenomena indicates that a knowledge of the relation between matter and electricity would lead to an increase of our knowledge of electricity, and further of that of chemical action, and, indeed, to an extension of the domain of electricity over that of chemistry. For the study of this relation the most promising course is to begin with that between electricity and matter in the gaseous or simpler state; and that is what is undertaken in this book. The subject is presented under the three general headings with numerous subheadings of The Discharge of Electricity through Gases, Photo Electric Effects, and Cathode Rays.

For a clear and concise presentation of the framework of psychology and its basal truths, the *Story of the Mind*[43] may be commended. Although the space afforded is only that of a bird's-eye view, no skeleton bristling with technical terms confronts us, but an attractive and well-furnished structure with glimpses of various divisions that tempt us to further examination. The text is simply and charmingly written, and may induce many to search the recesses of psychology who, under a less skillful guide, would be frightened away. A bibliography at the end of the volume supplies what other direction may be needed for more advanced study. Admirable in construction and treatment as the book is, there are, however, paths in which we can not follow where Professor Baldwin would lead, and in others that we undertake with him we do not recognize our surroundings as those he describes. This is especially the case with the environment of the genius. We do not find that "he and society agree in regard to the fitness of his thoughts," nor that "for the most part his judgment is *at once* also the social judgment." If such were the case, how would he "wait for recognition," or be "muzzled" for expressing his thoughts? In almost all [Pg 566] cases it is the story of Galileo over again. In art, science, and social reform he sees far beyond his fellows. Society can not accept him because it has not the vision of a genius. He contradicts its judgment and is fortunate when he escapes with the name of "crank." The military hero does not enter into this category: he glorifies the past rather than the future; he justifies the multitude in a good opinion of itself and, is therefore always received.

The first edition of Professor *Bolton's Catalogue of Scientific and Technical Periodicals*[44] was issued in 1885, and was intended to embrace the principal independent periodicals of every branch of pure and applied science, published in all countries from the rise of this literature to the present time, with full titles, names of editors, sequence of series, and other bibliographical details, arranged on a simple plan convenient for reference; omitting, with a few exceptions, serials constituting transactions of learned societies. In cases where the scientific character of the journal or its right to be classed as a periodical was doubtful, and in other debatable cases, the compiler followed Zuchold's maxim, that "in a bibliography it is much better that a book should be found which is not sought, than that one should be sought for and not found." The new edition contains as Part I a reprint from the plates of the first edition, with such changes necessary to bring the titles down to date as could be made without overrunning the plates; and in Part II additions to the titles of Part I that could not be inserted in the plates, together with about 3,600 new titles, bringing the whole number of titles up to 8,477, together with addenda, raising this number to 8,603, minus the numbers 4,955 to 5,000, which are skipped between the first and second parts. Chronological tables give the dates of the publication of each volume of the periodicals entered. A library check list shows in what American libraries the periodicals may be found. Cross-references are freely introduced. The material for the work has been gathered from all available bibliographies, and by personal examination of the shelves and catalogues of many libraries in the United States and Europe, and from responses to circulars sent out by the Smithsonian Institution. The whole work is a monument of prodigious labor industriously and faithfully performed.

In *Theories of the Will in the History of Philosophy*[45] a concise account is given by *Archibald Alexander* of the development of the theory of the will from the early days of Greek thought down to about the middle of the present century; including, however, only the theories of the more important philosophers. In addition to contributing something to the history of philosophy, it has been the author's purpose to introduce in this way a constructive explanation of voluntary action.

The account closes with the theory of Lotze; since the publication of which the methods of psychology have been greatly modified, if not revolutionized, by the development of the evolutional and physiological systems of study. The particular subjects considered are the theories of the will in the Socratic period, the Stoic and Epicurean theories; the theories in Christian theology, in British philosophy from Bacon to Reid, Continental theories from Descartes to Leibnitz, and theories in German philosophy from Kant to Lotze. The author has tried to avoid obtruding his own opinions, expressing an individual judgment only on matters of doubtful interpretation; and he recognizes that speculation and the introspective method of studying the will appear to have almost reached their limits.

Dr. *Frank Overton's* text-book of *Applied Physiology*[46] makes a new departure from the old methods of teaching physiology, in that it begins with the cells as the units of life and shows their relations to all the elements of the body and all the processes of human action. The fact of their fundamental nature and importance is emphasized throughout. The relation of oxidation— [Pg 567] oxidation within the cells—as the essential act of respiration—to the disappearance of food, the production of waste matters, and the development of force, is dwelt upon. The influence of alcohol is discussed in all its aspects, not in a separate chapter, but whenever it comes in place in connection with the several topics and subjects treated. Other narcotics are dealt with. A chapter on inflammation and taking cold is believed to be an entirely new feature in a school text book. Summaries and review topics are arranged at the end of each chapter; subjects from original demonstrations and the use of the microscope are listed; and many hygienic topics, such as air, ventilation, drinking water, clothing, bathing, bacteria, etc., are specially treated.

The prominent characteristic of Professors *F.P. Venable* and *J.L. Howe's* text-book on *Inorganic Chemistry according to the Periodic Law*[47] is expressed in the title, and is the adoption of the periodic law as the guiding principle of the treatment, and the keeping of it in the foreground throughout. So far as the authors have noticed, the complete introduction of this system has not been attempted before in any text book. They have made the experiment of following it closely in their classes, and their success through several years has convinced them of its value. "In no other way have we been able to secure such thorough results, both as to thorough, systematic instruction and economy of time. The task is rendered easier for both student and teacher." After the setting forth of definitions and general principles in the introduction, the elements are taken up and described according to their places and relations in the periodic groups, and then their compounds are described successively, with hydrogen, the halogens, oxygen, sulphur, and the nitrides, phosphides, carbides, silicides, and the alloys. The treatment is systematic, condensed, and clear.

The purpose of Mr. *John W. Troeger's* series of Nature-Study Readers is declared by the editor to be to supply supplementary reading for pupils who have been two years or more at school. They are composed, moreover, with a view to facilitating the recognition in the printed form of words already familiar to the ear, and to making the child at home with them. In carrying out this purpose the author takes advantage of the child's fondness for making observations, especially when attended by his companions or elders. In doing this the aim has been kept in view not to weary the child with details, and yet to give sufficient information to lead to accurate and complete observations. Most of the chapters in the present volume, *Harold's Rambles*, the second of the series, contain the information gleaned during walks and short excursions. Among the subjects concerned are birds, mammals, insects, earthworms, snails, astronomy, minerals, plants, grasses, vegetables, physics, and features connected with the farm. These Nature-study readers are published as a branch of Appletons' Home-Reading series. (New York: D. Appleton and Company. Price, 40 cents.)

Another of Appletons' Home-Reading Books is *News from the Birds*, which the author, *Leander S. Keyser*, explains has been written with two purposes in mind: first, to furnish actual instruction, to tell some new facts about bird life that have not yet been recited; and, second, to inspire in readers a taste for Nature study. It is by no means a key for the identification of the birds; but, instead of telling all that is or may be known respecting a particular bird, the author has sought only to recite such incidents as will spur the reader to go out into the fields and woods and study the birds in their native haunts. For the most part the author has given a record of his own observations, and not a reiteration of what others have said. He has gone to the birds themselves for his facts, and has made very little use of books.

It has been Mr. *Ernest A. Congdon's* aim, in preparing his *Brief Course in Qualitative Analysis* (New York: Henry Holt; 60 cents), to render it as concise as possible while making the least sacrifice of a study of reactions and solubilities of chemical importance. The manual covers the points of preliminary reactions on bases and acids; schemes of analysis for bases and acids; explanatory notes on the analyses; treatment of solid substances (powders, alloys, or metals); and [Pg 568] tables of solubilities of salts of the bases studied. A comprehensive list of questions, stimulative of thought, is appended. The book is intended merely as a laboratory guide, and should be supplemented by frequent "quiz classes" and by constant personal attention. The course has been satisfactorily given in the Drexel Institute within the allotted time of one laboratory period of four hours, and one hour for a lecture or quiz per week, during the school year of thirty-two weeks.

Lest we Forget is the title which President *David Starr Jordan* has given to his address before the graduating class of Leland Stanford Junior University, May 25, 1898—"lest we forget" the dangers and duties and responsibilities laid upon us by the war with Spain. Though delivered before the "policy of expansion" was fully developed, the address describes with prophetic accuracy the dream of imperialism with which the minds even of men usually sane and honest have become infected, and points out a few of the logical results to which they would lead, and the dangers which will have to be incurred in gratifying them. We cite a few of the strong points made by the author: "Our question is not what we shall do with Cuba, Porto Rico, and the Philippines; it is what these prizes will do to us." "Shall the war for Cuba Libre come to an inglorious end? If we make anything by it, it will be most inglorious." "I believe that the movement toward broad dominion, so eloquently outlined by Mr. Olney, would be a step downward."

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Fragments of Science.

Early Submarine Telegraphy.—The actual date of the beginning of subaqueous telegraphy was admitted by Professor Ayrtoun, in a lecture delivered before the Imperial Institute in 1897, to be uncertain. Baron Schilling is said to have exploded mines under the Neva by means of the electric current as early as 1812; and this method was used by Colonel Pasley to blow up the wreck of the Royal George at Spithead in 1838; but our Morse has the credit of having first used a wire insulated with India rubber under water. In 1837, Wheatstone and Cooke were experimenting with land telegraphy, and were considering the possibility of laying an insulated wire under water. Morse's successful experiments date from 1842, when he personally laid a cable between Castle Garden and Governor's Island and sent messages over it; the next morning it was broken. With the introduction of gutta percha as an insulator in 1847, submarine telegraphy became practicable. The Central Oceanic Telegraph Company had been registered by Jacob Brett in 1845, and a cable was laid under the English Channel by Brett and his brother in 1850. Messages were sent through it, but, like Morse's earlier effort, it immediately became silent. Better success attended the cable of the next year, which was sheathed with iron; and the first public submarine message was sent over it November 13, 1851. Morse wrote of the possibility of establishing electro-magnetic communication across the ocean as early as 1844. A syndicate was formed for this purpose in 1855, Cyrus W. Field being the most conspicuous figure in it. An understanding was reached with the Brett company, and the Atlantic Telegraph Company was formed. The first effort to lay the cable was made in 1857 by the United States frigate Niagara and H.M.S. Agamemnon, but the wires broke in deep water when about a third of the work was done. A cable was successfully laid the next year, but it died out in a month. Finally, electric communication was permanently established across the Atlantic by the Telegraph Construction and Maintenance Company, which, capturing a cable that had been lost, soon had two. Transatlantic cables have now become so numerous and so regular in their working that the danger of even a temporary failure has become very remote.

The White Lady Mountain.—Iztaccihuatl (pronounced Is-tak-see-watl) is about ten miles, measuring to its principal peak, north of Popocatepetl. In shape it consists of a long, narrow ridge cut into three well-defined peaks about equally distant from one another, of which the central is the highest; and the snow-covered peak resembles the figure of a woman lying on her back; whence the name of the mountain, which means *white woman*. According to the Aztecs, Dr. O.C. Farrington, of the Field Columbian Museum, tells us, this woman was a goddess who for some crime had been struck dead and doomed to lie forever on this spot. Popocatepetl was her lover, and had stood by her. Tastes differ as to whether it or Popocatepetl presents a more striking view, but either is a beautiful enough object to look upon. The first authenticated record of an ascent to the summit of the mountain is that of Mr. H. Reniere Whitehouse, who reached the top November 9, 1889, and found there undoubted evidence that an ascent had been made five days previously by Mr. James de Salis. Prof. Angelo Heilprin and Mr. F. C. Baker attempted an ascent in the following April, but were turned back when about seventy-five yards below the summit, at a height of 16,730 feet, by two impassable crevasses. "The ascent of Iztaccihuatl seems, therefore, pretty generally to have foiled those who have attempted it. Dr. Farrington, who ascended to the Porfirio Diaz Glacier in February, 1896, describes the route as steeper than that which leads up to Popocatepetl." The brilliant and varied flora, picturesque barrenness, and beautiful cascades lend everywhere a charm to the scene which contrasts favorably with the somber monotony which characterizes the route by which Popocatepetl is ascended. The slopes of the mountain are cultivated to a considerable height—10,860 feet. The lower slopes are largely covered with soil, and the andesite rock, of gray and red colors, differs completely in character from that of Popocatepetl. The aiguillelike character of many of the spurs extending at right angles to the course of the mountain is a prominent feature. Many caves in the rock furnish shelter to cattle and persons attempting the ascent. Dr. Farrington examined the Porfirio Diaz Glacier, and concluded that it formerly had a much greater extent than now.

The Adulteration of Butter with Glucose.—The following is from an article by C.A. Crampton in the Journal of the American Chemical Society: In domestic practice the addition of sugar to butter for purposes of preservation is doubtless almost as old as the art of butter-making itself; salt, however, is the usually preferred preservative. Sugar appears in several of the various United States patents for so-called "improving" or renovating processes for butter, being added to it along with salt, saltpeter, and in some cases sodium carbonate. Within the past few years glucose has been used in butter specially prepared for export to tropical countries, as the West Indies or South America. It is usually put up in tins, and various means are resorted to for preventing the decomposition of their goods before they reach the consumer. Very large quantities of salt are used by the French exporters, as the following two analyses show:

	Butter for Export.	
	To Brazil.	To Antilles.
Water	10.29	10.19
Curd	1.24	1.31
Ash	10.29	10.06
Fat	78.18	78.44
	———	———
	100.00	100.00

Chemical antiseptics, borax, salicylic acid, etc., are sometimes used, but the method found most efficacious by exporters in this country seems to be the use of glucose in conjunction with moderately heavy salting. The glucose used is a heavy, low-converted sirup, known as confectioners' glucose. The detection of glucose in butter presents no difficulty. The butter is thoroughly washed with hot water, which will readily take up whatever glucose is present. This solution is then tested by means of Fehling's solution. The following is an analysis of the so-called *beurre rouge*, or red butter, which is exported to Guadeloupe. It is a peculiar highly colored compound, containing large quantities of salt and glucose:

Water	21.60
Curd	0.81
Ash	16.42
Fat	51.15
Glucose	10.02
	———
	100.00

Decorated Skulls and the Power ascribed to them.—A collection of sixteen skulls—eight of men, seven of women, and one of a child—from New Guinea, is described by George A. Dorsey in the publications of the Field Columbian Museum, Chicago. They were received from a native [Pg 571] chief, who used them for the adornment of his house, and is said to have prized them as trophies of war. They are decorated in the frontal region by engraved designs, and the parts are attached to one another by very skillfully adjusted cords. The ornamentation and the bindings are the subject of a special comment by William H. Holmes. Importance is attached by natives of New Guinea to the preservation of the skulls of friends as mementoes and of foes as trophies, and of both categories on account of the virtue—the best qualities of the individuals whose skulls they are—which they are supposed to impart in some mysterious way to their possessor. Hence special care is taken to have them preserved in detail, and that no part be lost. In the present specimens the jaws were secured by fastenings at right and left and in front. The teeth were carefully tied in, and when lost were replaced by artificial teeth. A cord was fastened around the back molar on one side, and carried along, inclosing each tooth in turn, in a loop, so as to make a very effective fastening when the cord was tightly drawn and attached to the back molar on the other side. The lower jaw was very firmly fastened to the skull by closely wrapped cords tightened by binding the strands around the middle portion. In some cases these fastenings are very elaborate and neat; in others, imperfect and slovenly. All the skulls in the collection are decorated with designs engraved on the frontal bone, and in some cases the figures run back. The execution of the work is not of a very high order, but is rather irregular and scratchy. Nearly all embody easily distinguished animal forms, and the more formal or nearly geometric ones are probably animal derivatives or representations of land, water, or natural phenomena. They are possibly totemic or mythological.

Galax and its Affinities.—One of the most interesting plants of the Southern mountain region is the galax (*Galax aphylla*), which grows in the highlands more or less abundantly from Virginia southward. The slopes of Grandfather Mountain, North Carolina, are carpeted with it for many square miles of almost uninterrupted extent. Besides being an attractive plant at home, its thick, leathery, rounded cordate leaves, deep green or crimson or mixed, according to the season, make it much in demand for decoration, and tons of it in the aggregate are shipped, from places where it grows abundantly, for that purpose. Its affiliations with certain other Alpine and arctic plants are described in a carefully studied paper on the Order Diapensisceæ, published by Margaret Farsman Boynton in the Journal of the National Science Club, Washington. Linnæus found in Lapland a creeping evergreen herb, matting the surface with its stiff, spatulate leaves, and described it in 1737 as *Diapensia lapponica*. Then galax was discovered by Gronovius and given a place by Linnæus—because of its stamens rather than of its natural affinities—along with Diapensia. Michaux, in the last decade of the eighteenth century, found *Pyxidanthera barbulata*, resembling diapensia, in the pine barrens of New Jersey and North Carolina. More recently other species of diapensia and *Berneuxia* have been found among the Himalayas, and *Schizocodon* of several species in Japan. One of the most remarkable discoveries in the list was that by Michaux in the mountains of North Carolina of a plant which was afterward called *Shortia galacifolia*, from the resemblance of its leaves to those of galax. This plant in a living state was then lost, and when Gray and Torrey looked for it in 1831 in vain, only one preserved specimen of it was known to be extant and that in fruit; and it was not till 1877 that it was collected, rediscovered, in fact, in flower, as Gray has said, "by an herbalist almost absolutely ignorant of botany, who was only informed of his good fortune on sending to a botanist one of the two specimens collected by him." The Shortia, so far as is known, grows only in a very narrow district, and those who know the place are careful not to direct the public to it. Specimens have been collected by a few nurserymen, who cultivate it and have it for sale. The plants of this list are variously classified as among one another by botanists, but are regarded as belonging to a common group. "The real story of their development," says the author of the paper, "can be gathered only in hints from their present distribution, for unfortunately they have neither gallery of ancestral portraits nor recorded geological tree." But their ancestors are supposed to have been pushed down by the [Pg 572] glaciers and left where the modern forms are found. Almost anywhere in the boreal flora *Diapensia lapponica* may be found, whether in northern Asia, or Europe, or America, or even on the mountains of Labrador and in the Pyrenees, the Scotch mountains, and our own White Mountains.

The Academy della Crusca.—"For three hundred years," says a correspondent of the London Athenæum, "the learned body, the Academy of la Crusca (the bran), Florence, has been scrupulously sifting the Italian tongue and producing successive editions of its monumental dictionary. Its present seat is in the monastery of St. Mark—Savonarola's cloister—where it occupies the hall behind the great library. When an associate is promoted to full membership, his official reception is still accompanied by the traditional rite. First, he is solemnly conducted to the Cruscan museum, and left to solitary meditation among shovel-backed chairs surmounted by the symbolical sieve and bookcases ingeniously fashioned in the likeness of corn sacks. The walls are covered with the names, crests, and mottoes of former members, who in past times usually assumed fantastic titles descriptive of the academy's labors." Some of these printed inscriptions and comical devices are more or less quaint. Thus, Dr. Giulio Maxi in 1590 took the name of *Il Fiorito*, or the flowery one, with the device of a basket of wheat in bloom and the motto from Petrarch (translation):

> "I enjoy the present and hope for better."

In 1641 the Senator Vieri appeared as *Le Svanito*, the evaporated, with an uncorked wine flask, the stopper beside it, and the motto:

> "Oh, how I long for the medicine!"

In 1660 the Marquis Malaskini adopted the title of *Il Preservato*, the preserved, the device of olives packed in straw, and the motto from Petrarch:

> "Keep the prize green."

In 1764, the Abbot Giuseppe Pelli, surnamed *Il Megliorato*, the improved, took the device of a newly invented sieve for the better sifting of grain, with the Petrarchian motto:

> "Follow the few, and not the throng."

In 1770, Signor Domenico Manni assumed the title of *Il Sofferente*, the sufferer, with a straw chair as his device, and a motto from Dante:

> "The master said that lying in a feather bed
> One would not come to fame—nor under the plowshare."

In due time the new member is escorted to the hall where the academy is assembled, and the chief consul, head of the academy, greets him with a speech, to which he has to make a fitting reply. Historical Italian families are numerously represented on the academy's rolls, and among the foreign members are the names of William Roscoe and Mr. Gladstone.

Aboriginal Superstitions about Bones.—A very interesting archaeological site in Mexico, visited by Carl Lumholtz and Aleš Hedlička in the fall of 1896, is near Zacápu, in the State of Michoacan. The region is marked by many stone mounds on or near the edge of the old flow of lava, extending for several miles; and directly above the village stands a large stone fortress, called El Palacio. Excavating near this fortress, Mr. Lumholtz unearthed several skeletons, which had been buried without any order, and accompanied by "remarkably few objects," but some of these were well worthy of study. The most curious things found were some bones, strangely marked with grooves across them, exhibiting a little variety in arrangement, but all similarly executed, and evidently after a carefully devised system. This feature is so far unique in archæology, and its purpose can as yet be only a matter of conjecture. Two ways are proposed by the author of explaining it. The marking may have been an operation undertaken for the purpose of dispatching the dead. Mr. Lumholtz is knowing to a belief among the tribes of Mexico that the dead are troublesome to the survivors for at least one year, and certain ceremonies and feasts in regard to them have to be observed in order to prevent them from doing harm, and to drive them away. The Tarahumares guard their beer against them, and others provide a special altar with food for the dead on it at their rain-making feasts, else the spirits would work some mischief. Among many tribes an offering is made to the dead, before drinking brandy, of a few drops of the [Pg 573] liquor. A relation is also supposed to exist between disease and pain and the bones of the deceased person. A whole class of diseases are supposed to have their seat in the bones or the marrow of them. If the disease does not yield to the shaman's efforts, and causes death, the Indians think that the pain will continue after death and vex the ghost, making him malignant and troublesome. Therefore the pain must be conquered, and driven away from the bones and the marrow. Hence the markings may have been made in order to sever all connection between the spirit and his former life, and from the disease that caused his death. The other explanation is that the bones were taken from slain enemies for other purposes than as mere trophies. Personal or bodily relics are supposed to possess some of the qualities of the deceased, and to give power. This view is supported by some observations of Mr. Cushing relative to Zuñi customs; and the author is inclined to favor it rather than the other.

Estrays from Civilization.—A curious study of a community of estrays from civilization who are leading the life of savages is published by M. Zaborowski in the *Revue de l'École d'Anthropologie* and *La Nature*. The settlement is about a mile from Ezy, on the eastern edge of the plateau of Normandy, in a group of caves that were excavated and used as wine cellars when, several hundred years ago, wine culture flourished in the now uncongenial region. Later the spot was a resort for picnics till the old buildings fell into decay, and about fifty years ago it was given up to wanderers. About eighty men, women, and children live there, the adults, though not perhaps really criminals, having been lost to society on account of some offense committed against it. They have no regular means of subsistence, are beneath the tramps in grade, and possess, with one or two exceptions, no articles of property other than what they pick up. Their beds are wooden bunks set upon stones, filled with leaves, and the coverings are wrapping canvas. A "family" of seven persons lived in one of the cellars with only a single bed of this kind. Their kitchen utensils are old tin cans picked out of rubbish heaps, and their stoves are obtained in the same way, or often consist of plates and pieces of iron adjusted so as to make a sort of fireplace. They have a well from which they draw water with some old kettle suspended on a hooked stick, each "family" having its own hook. Their clothes are rags, partly covering portions of the body, and it is not considered necessary that the younger ones should have even these. Their housekeeping and their ideas of neatness are such as might correspond with these conditions. One woman, mother of four children, and the only one that was adequately dressed, was a native of a neighboring village, and had been brought to the cave by her mother when she was eight years old. An old man had been a charge upon the town and was sent to the cave by the *maire* to get rid of him. He had found a woman there and had several children. A woman, still active, who had lived in the caves three years, had children living in Ezy. The complaint, so common in other parts of France, that the natural increase of population has failed, does not apply to the caves. Five or six of the "families" have four or five children. On these children, of whom only the most vigorous survive, "the influence of their debasing misery and of the vices of their parents impresses a common aspect. Their mental condition has fallen shockingly low, and, their physical needs satisfied, they seem to want nothing further. No attraction will induce them to attend school, which is like imprisonment to them. Their mode of life and the marks of degradation in their faces separate them from others. Earnest attempts to develop their intelligence and moral consciousness have been without result."

German School Journeys.—It is very common in Germany, says Miss Dodd, of Owens College, in one of the English educational reports, to find definite teaching taking place outside the school walls—in the gardens attached to the schools, and in the neighboring forests, where the children are instructed in observation of the local forms of plant and animal life. Further, they are often taken on longer expeditions to spend the whole day in the forest or on the mountain with their teachers, who direct them "what to see, and how to see it." More definite and more ambitious [Pg 574] than these minor excursions is the school journey, which may last from three days to three weeks. It is usually taken on foot, and is as inexpensive as possible, with plain food and simple accommodation. Each boy carries his own knapsack charged with a change of underclothing, towels, soap, etc., and overcoat or umbrella; while for the common use of the party are distributed clothes brushes and shoe brushes, needles, thread, string, and pins, ointment for rubbing on the feet, a small medicine chest, a compass, a field glass, a pocket microscope, a barometer, and a tape measure. The district visited is chosen on account of its historical associations or the geographical illustrations it furnishes, or the richness and variety of plant life to be studied. Constant pauses are made to afford opportunities for the examination of features inviting study; and the scenes visited are often closely connected with the subjects included in the year's work of the school. In a journey, of which Miss Dodd was a member, preparations were begun three months beforehand, with the collection of subscriptions, drawing of road maps, and special lessons. The fifty boys from ten to fifteen years old, marched off in groups of four, assorting themselves according to their affinities for companionship, with advance and rear guards; the regions passed through were explored for what might be found in them; the roads were marked and identified, mountains and rivers were named, and the courses of streams determined; and at each place of considerable interest its characteristic features and associations of Nature, art, and history were discussed and studied.

The Huichol Indians of Jalisco.—The Huichol Indians of Mexico, the subject of a study by Carl Lumholtz, four thousand people living in the mountains of northern Jalisco, have a tradition that they originated in the south, got lost underneath the earth, and came forward again in the east, in the country of the *Kikuli*, near San Luis Potosi. Franciscan missionaries converted them nominally to Christianity, but there are now no priests in their country, and there is probably no tribe in Mexico where the ancient beliefs have been so well maintained as with them. Their exterior conditions have been somewhat altered by the introduction of cattle and sheep, and cattle are now the favorite animals for sacrifice at the feasts for making rain during the dry season. The people are healthy, very emotional, easily moved to laughter or tears, imaginative and excitable. Young people show affection in public, kissing or caressing one another. They are kind-hearted and not inhospitable to those who can gain their confidence, but have the reputation of being wanting in regard for truth. They live mostly in circular houses made from loose stones, or stones and mud, and covered with thatched roofs. Their temples, devoted to various gods, are of similar shape, but much larger, with the entrances toward sunrise. Outside of the door is an open space surrounded by small rectangular god-houses, with gabled and thatched roofs. The god-houses are also frequently found in the forests, and are sometimes circular. There are nineteen temples in the country which are frequented at the times of the feasts, when the officials and their families camp in the small god-houses. Idols are not kept in the temples, but are hidden in caves or in special buildings. There are a great many sacred caves devoted to various gods, and generally containing some pool or spring that gives them sanctity, and the water of which is supposed to have salutary virtues. Much religious importance is attached to the *Kikuli* cactus, which produces an exhilarating effect on the system. Ceremonial arrows are inseparably connected with their life, the arrow representing the Indian himself in his prayers to the gods. They have other interesting ceremonies and ceremonial objects, and a curious system of distilling, which Mr. Lumholtz describes at length.

Herrings at Dinner.—The food of the herring consists of small organisms, often of microscopic dimensions. It is entirely animal, and in Europe, according to those who have investigated the matter, it consists of copepods, schizopods (shrimplike forms), amphipods (sand fleas and their allies), the embryos of gasteropods and lamellibranchia, and young fishes, often of its own kind. In the examination of about fifteen hundred specimens of herring at Eastport, Maine, and vicinity, in the summer and fall of 1893, Mr. H.F. Moore, of the Fish Commission, found only two [Pg 575] kinds of food—copepods or "red seed," which appeared to constitute the sole food of the small herrings, and shrimps the principal food of the larger ones. In many cases the stomachs of the fish were densely gorged with these shrimps, which are extremely abundant in the waters of the vicinity. Excepting the eyes and phosphorescent spots beneath, which are bright red, the bodies of the crustaceans are almost transparent, yet such is the density of the schools in which they congregate that a distinctly reddish tinge is often imparted to the water. They are very active, and frequently avoid the rush of the fish by vigorous strokes of their powerful caudal paddles, which throw them several inches above the surface. To capture them requires some address on the part of the herring, and the fish likewise frequently throw themselves almost clear of the surface. When feeding upon copepods the movements of the herrings are less impetuous. They swim open-mouthed, often with their snouts at the surface, crossing and recrossing on their tracks, and evidently straining out the minute crustaceans by means of their branchial sieves. After they have passed the stage known as "brit," the herrings appear to feed principally at night, or if they do so to any considerable extent during bright daylight it is at such a depth that they escape observation. At night it is often possible to note the movements of the fish at a depth of several fathoms, and at such times Mr. Moore has seen them swimming back and forth, "apparently screening the water, their every movement traced by a phosphorescent gleam, evoked perhaps from the very organisms which they were consuming." The herrings evidently follow their prey by night, and the fact that the shrimps possess phosphorescent spots may explain the apparent ability of the fish to catch them then.

MINOR PARAGRAPHS.

The phosphorescence, which is so beautiful a characteristic of certain forms of animal life in the sea, has been the cause of much speculation among the fishermen and scientists; none of the proposed theories have been entirely satisfactory. It is now stated, however, that an adequate and provable cause has been discovered in a so-called species of photo-bacteria; by means of this germ it is stated that sea water, containing nutrient media, can be inoculated and rendered phosphorescent; that newly caught herrings with the sea water still fresh can be rendered phosphorescent by a treatment which favors the growth of the photo-bacteria. Oxygen is an essential to their growth.

Personal equation was defined by Prof. T.H. Safford, in a paper read at the American Association, as in reality the time it takes to think; and as that time is different in different persons, observations are liable to be affected by it unless correct allowance is made for it in the case of each one. It has been a subject of discussion since the end of the last century. The Astronomer

Royal of England discharged a good assistant in 1795, because he was liable to observe stars more than half a second too late. Bond, several years afterward, took the subject up and found that astronomers were liable to vary a little in their observations; some to anticipate the time by a trifle, and others falling a little behind. The subject has since been studied by Professor Wundt. In the days when the eye-and-ear method of observation prevailed, the astronomer had both to watch his object and to keep note of the time; with the introduction of the chronograph, the errors resulting from this necessity are in part obviated. But error enough still exists to be troublesome.

The Educational Extension Work in Agriculture of Cornell University Experiment Station is carried on by the publication and distribution of leaflets, visitation of teachers' institutes, and other means that may bring the station in contact with the people. The results of the work have been generally satisfactory. Eight leaflets, on such subjects as How a Squash Plant gets out of the Seed, A Children's Garden, etc., were published last year in from two to six editions, and still meet a lively demand. Thirty thousand teachers were enrolled on the lists as receiving leaflets, or as students of methods of presenting Nature study to their pupils, sixteen thousand school children were receiving leaflets suitable to them, and twenty-five hundred young farmers were [Pg 576] enrolled in the Agricultural Reading Course. Much interest seems to have been shown by farmers in sugar-beet culture, in investigations of which more than three hundred of them are cooperating with the station, and two hundred in experiments with fertilizers.

NOTES.

An important feature in the evolution of trade journalism is pointed out in the presidential address of E.C. Brown, of the American Trade Press Association, in the establishment of small trade journals, covering limited fields. Such industries as brickmaking, stenography, advertising, acetylene, hospital practice, etc., are ably represented by their respective trade journals; and this tendency is promoted by the complementary one of the trades, in their centralization and concentration, compelling even journals in the same business to make their field distinct and restricted. The public demands specific information, not for the purpose of catering to a passing interest, but for its application directly in the conduct of business or the formation of a policy; and those trade journals succeed best which supply accurate information of value to their readers.

The ascent of Mont Blanc was accomplished between June 21st and September 16th by one hundred and nineteen persons, eleven of whom were women. By nationality the climbers included forty-four Frenchmen and eleven Frenchwomen, fifteen Englishmen and one Englishwoman, and fifteen Swiss, with Germans, Americans, Belgians, Hollanders, Irish, and Russians. A Belgian lady and a Dutch lady were of this company. A Frenchwoman, seventy-five years old, was one of the party that reached the summit on one of the last days in September.

Mr. Horace Brown, whose interesting researches on the enzymes have attracted much attention during the past few years, has recently announced the results of some important experiments on the vitality of seeds. He found that certain seeds subjected to the very low temperature of evaporating liquid air, about -192° C., for one hundred and ten consecutive hours, retained perfectly their power of germinating.

The report made by Prof. W.A. Herdman to the British Association concerning the liability to disease through oysters recognizes the possibility of contamination through the proximity of the beds to sewage water, and recommends steps to be taken, through either legislative control or association, to induce the oyster trade to remove any possible suspicion of contamination of the beds; provision for the inspection of foreign oysters or their subjection to a quarantine by deposition for a stated period in British waters, as already takes place in many instances; and the periodical inspection of the grounds from which mussels, cockles, and periwinkles are gathered.

As the result of long-continued observations of annual temperatures the appearance of the earliest leaves, and the return of birds of passage, M. Camille Flammarion has published the conclusions that the maximum temperatures correspond with abundant sun spots and the least humidity, and the minimum temperatures with scarcity of sun spots and great humidity; and that sparrows begin to sit when horse-chestnuts, lilacs, and peonies begin to bloom, and the young are hatched about two days after these plants are in full inflorescence. M. Flammarion also believes that the temperatures of March and April indicate those of the entire year.

Little steel capsules containing a small quantity of liquefied carbonic acid are made, *La Nature* says, at Zurich, Switzerland. One of them is placed in the neck of a bottle of water which is provided with a faucet and the capsule is pricked. The carbonic acid escapes and charges the water, and a bottle of soda water is the result. The capsules are cheap and convenient, and are very popular in Switzerland and Germany.

It is proposed to erect a memorial to James Clerk Maxwell in the parish church of Corsock, of which he was a trustee and elder. Subscriptions may be sent to the Rev. George Stimock, The Manse, Corsock by Dalbeattie, N.B.

Our obituary list includes among men well known in science the names of Edward Dunkin, an English practical astronomer, for fifty years an assistant and part of the time chief assistant at the Royal Observatory, Greenwich, a contributor of many paper on practical astronomy, aged seventy-seven years; H. Vogel, professor of photography, photo-chemistry, and spectroscopy in the Technical High School, Berlin, author of The Chemistry of Light and Photography, in the International Scientific Series, in his sixty-fifth year; Alexandre Pillet, curator of the Musée Dupuytre, Paris, and well known for his contributions on morbid anatomy, at Paris, November 2d, aged eighty-eight years; George T. Allmann, formerly professor of botany in Dublin and of natural history in Edinburgh, who described the hydroids collected by the Challenger Expedition, and was author of a number of monographs on the invertebrates, aged eighty-six; Thomas Sanderson Bulmer, investigator in American archæology and ethnography, and contributor to Filling's Bibliographies of American Languages, at Sierra Blanca, Texas, October 5th; and Dr. Ewald Geissler, professor of chemistry at the veterinary school of Dresden, aged fifty years.

FOOTNOTES:

[1] In 1872, while a Commissioner of Health, I had occasion to examine and report on the causes of the high death rate during the summer months in the city of New York. The chief cause was determined to be the excessive heat which characterizes those months. It was recommended in the report to the Board of Health that legislation be secured empowering and requiring the Department of Parks to plant and cultivate trees, shrubs, plants, and vines in all the streets, avenues, and public places in the city. A bill was drafted and introduced into the Legislature, but it did not become a law, and no further effort has been made to secure such legislation. Meantime, two tree-planting societies have been established, one in the Borough of Brooklyn and the other in the Borough of Manhattan, which are endeavoring to awaken public interest to the importance of planting a suitable number and variety of trees in the streets for purposes of ornamentation. The aim of this paper, which is largely based on the report of 1872, is to revive the project of giving the Department of Parks jurisdiction over the trees in the streets, and require it to plant and cultivate additional trees, shrubs, plants, and other forms of vegetation for the improvement of the public health and for the purpose of ornamentation.

[2] Man and Nature. G.P. Marsh, New York, 1872.

[3] It is interesting to notice, in this connection, the remark of Angus Smith, that a temperature of 54° F. is important in the decomposition of animal and vegetable matter.

[4] Public Parks. By John H. Rauch, M.D., Chicago, 1869.

[5] Les Arbres, quoted by Marsh.

[6] The late Dr. Francis remarked that he had noticed a marked increase in the fatality of diseases in sections of the city after the removal of trees and all vegetation.

[7] The Groundwork of Science. A Study of Epistemology. By St. George Mivart, M.D., Ph.D., F.R.S. New York: G.P. Putnam's Sons, 1898.

[8] The position of the solid rock is shown by the hammer at the extreme right, standing vertically.

[9] This photograph represents a more detailed view of the quarry wall seen in Fig. 1. The relation of the two views will be understood by observing the positions of the hammers, which are in the same place in both photographs. These photographs, as well as some of the others that follow, were taken by Mr. John L. Gardner, 2d, for the purpose of illustrating these pages.

[10] In order to obtain this sketch, a survey was made of the delta, and from the information thus gathered a model was constructed out of clay. The dimensions of the delta are about one thousand by seven hundred feet.

[11] The bottom of the cañon at this point is between four and five thousand feet below the flat surfaces in the foreground—a sheer descent of nearly a mile.

[12] To those who are interested in the subject of indentured labor in the tropics, the following statistics, compiled by me from official sources, may be of interest. The figures relate to British Guiana:

Year.	Number of indentur'd laborers imported from India.	Number of time-expired immigrants who returned to India.	Value in dollars of money and ornaments carried back to India by returning immigrants.	Number of East Indian depositors in the Gov't Savings Bank.	Total amount of their deposits, in dollars.	Number of planters convicted of offenses against immigrants.	Death rate per 1,000 among indentured laborers.	General death rate of the colony.
1886	4,796	1,889	111,775	5,558	425,956	9	27.40	25.56
1887	3,928	1,420	92,613	5,821	438,600	4	23.20	32.41
1888	2,771	1,938	95,074	5,904	457,886	1	19.73	29.27
1889	3,573	2,042	112,124	6,802	513,220	1	12.57	28.13
1890	3,432	2,125	142,611	7,269	558,734	3	20.40	39.80
1891	5,229	2,151	134,225	6,398	515,246	2	20.40	37.00
1892	5,241	2,014	97,529	6,085	527,203	1	25.20	39.00
1893	4,146	1,848	104,763	6,179	544,420	1	24.91	35.00
1894	9,585	1,998	113,308	6,128	529,161	2	24.22	33.53
1895	2,425	2,071	119,289	4,950	453,950	1	20.36	29.58

1896	2,408	2,059	76,470	4,520	434,759	1	16.50	24.10

[13] "Senator Paddock: I should like to ask the Senator from Nevada if, in the region of country where borax is found, by reason of finding it the land in the particular State or Territory is appreciated in value on account of its existence.

"Senator Stewart: Not at all.

"Senator Paddock: The value then given to it is all in labor."—*Congressional Record, July, 1890.*

[14] "In America, where there has been but little serious study of taxation, the few writers of prominence are, remarkable to relate, almost all abject followers of Thiers," the French economist and statesman, who claimed to have invented the term "diffusion" of taxes.

[15] "Our conclusion is, that under actual conditions in America to-day the landowner may virtually be declared to pay in the last instance the taxes that are imposed on his land, and that at all events it is absolutely erroneous to assume any general shifting to the consumer. In so far as our land tax is a part of a general property tax, it can not possibly be shifted; in so far as it is more or less an exclusive tax, it is even then apt to remain where it is first put—on the landowner."—*Seligman: Incidence of Taxation, p. 99.*

[16] Seligman. Shifting and Incidence of Taxation.

[17] Professor Marshall.

[18] In a like experience the Duke of Argyll, in his work The Unseen Foundations of Society, finds an explanation of the so-called theory of Ricardo, that the rent which a farmer of agricultural land pays as the price of its hire—that is to say, the price which he pays for the exclusive use of it—is no part of the cost of the crops he may raise upon it; a conclusion that can not be possibly true, unless it be also true that rent is paid for something that is not an indispensable condition of agricultural production. "Thus rights are in their very nature impalpable and invisible. They are not material things, but relations between many material things and the human mind and will. The right of exclusive use over land is a thing invisible and immaterial, as other rights are, and, although it is, and has been since the world began, the basis of all agricultural industry, it is a basis impalpable and invisible, whereas the material visible implements and tools, whose work depends upon it, are all visible and palpable enough, and all of which would never be were we to see them without the invisible rights upon which they depend. All of the former, in their place and order, are instruments of production; all of them catch the eye, and may easily engross the attention. On the other hand, if we are induced to forget those other elements, which are equally essential instruments of production, merely because they are out of sight, then our deception may be complete, and fallacies which become glaring when memory and attention are awakened may find in our half-vacant minds an easy and even a cordial reception."

Adam Smith may be fairly considered as having fully committed himself beyond all controversy in his great work, The Wealth of Nations, to the principle that taxes, with a degree of infallibility, diffuse themselves when they are levied uniformly on the same article; and he even goes so far as to admit that a tax upon labor, if it could be uniformly levied and collected, would be diffused, and that the laborer would be the mere conduit through which the tax would pass to the public treasury. Thus he says, "While the demand for labor and the price of provisions, therefore, remain the same, a direct tax upon wages can have no other effect than to raise them somewhat higher than the tax."

The German economist Bluntschli, who has carefully studied this question of the final incidence of all just and equitable taxes, is in substantial agreement with the above conclusions, but prefers to use a different term for characterizing such finality than consumption, and expresses himself as follows: "In the end taxes fall on *enjoyments*. Hence the amount of each man's enjoyments and not his income is the justest measure of taxation." (Bluntschli, vol. x, p. 146.)

M. Thiers, the French statesman and economist, was also a believer and earnest advocate of the theory of the diffusion of taxes, and lays down his principles in the following words: "Taxes are shifted indefinitely, and tend to become a part of the price of commodities, to such an extent that every one bears his share, not in proportion to what he pays the state, but in proportion to what he consumes." And in his book Rights to Property he thus illustrates the method in which taxation diffuses itself: "In the same manner as our senses, deceived by appearances, tell us that it is the sun which moves and not the earth, so a particular tax appears to fall upon one class, and another tax upon another class, when in reality it is not so. The tax really best suited to the poorest member of society is that which is best suited to the general fortune of the state; a fortune which is much more for the possession and enjoyment of the poor man than it is for the rich; a fact of which we are never sufficiently convinced. But of the manner, nevertheless, in which taxes are divided among the different classes of the state, the most certain thing we can say is: That they are divided in proportion to what each man consumes, and for a reason not generally recognized or understood, namely, that taxes are reflected, as it were, to infinity, and from reflection to reflection become eventually an integral part of the prices of things. Hence the greatest purchasers and consumers are everywhere the greatest taxpayers. This is what I call '*diffusion of taxation*,' to borrow a term from physical science, which applies the expression 'diffusion of light' to those numberless reflections, in consequence of which the light which has penetrated the slightest aperture spreads itself around in every direction, and in such a manner as to reach all the objects which it renders visible. So a tax which at first sight appears to be paid directly, in reality is only advanced by the individual who is first called upon to pay it."

[19] As applied to the wages of labor, the truth of this principle is equally incontestable. "The sewing girl performing her toilsome work by the needle at one dollar a day, the street sweeper working the mud with his broom at a dollar and a half, the skilled laborer at two and three dollars, the professor at five, the editor at five or ten, the artist and the songstress at ten or five hundred dollars a day are all members of the working classes, though working at different rates. And it is only the difference in their effectiveness that causes the difference in their earnings. Bring them all to the same point of efficiency, and their earnings also will be the same."—*W. Jungst, Cincinnati.*

John Locke, in his treatise On the Standard of Value, treats of taxation, and shows conclusively that if all lands were nominally free from taxation, the owners of lands would proportionally pay more taxes than now, because the same amount of money must continue to be collected in some form, and the average profits of lands would only be equal to the average profits of other investments; and further, that the expense and annoyance (another form of expense) would be increased if the tax were exclusively levied in the first instance upon personal property; and hence the landowner would be burdened with his proportion of the unnecessary expense and annoyance. He also shows that you may change the form of a uniform tax, but that you can not change the burden; and that the change will increase the burden, if the new system is more expensive and annoying than the old. Locke wrote nearly a century before Adam Smith published his Wealth of Nations, and it would seem probable that Smith acquired his ideas relative to the average profits of investments from Locke.

[20] The meteors shown in the two ideal pictures are, of course, entirely disproportionate in size to the earth and stars. If seen by an observer above the earth, we might imagine an envelope of light around the globe from the continuous ignition of the 150,000,000,000 or more meteors which it is estimated strike the earth every year; in which case, the striking meteors would be represented in the illustrations as a thin light line surrounding the atmospheric envelope of the earth.

[21] The pessimists are further mistaken. The idea that conquest is disastrous, even to the conqueror, is much more widespread in modern societies than is generally thought. But social reflexes urge the masses to obey their chief blindly. It requires only a Gothic spirit—like Bismarck, for example—to set a whole army in motion, and make it do things which every officer and every soldier would condemn as a personal act.

[22] The difference is the extent of Alsace-Lorraine.

[23] About the extent of the British Isles, Belgium, Holland, and Switzerland combined.

[24] See Seeley's Expansion of England, p. 21. This figure is very moderate. Between 1802 and 1813 France alone spent 498,000,000 francs ($99,600,000) a year. See Laroque, La Guerre et les Armées permanentes, Paris, 1870, p. 203.

[25] See P. Leroy-Beaulieu, Recherches économiques sur les Guerres contemporaines, Paris, p. 181.

[26] We may refer here to another loss which has never been thought of till now. It was long fancied that wealth could be acquired more rapidly by war than by work; consequently, conquest seeming to be the most rapid and therefore most efficacious way, was honored, and labor, appearing to be a slower process, was despised. In our days a large number of descendants of the knights of the middle ages retain the ideas of their ancestors and look upon labor as degrading. Hence thousands of aristocrats do nothing, but remain social good-for-nothings, retarding the increase of wealth by their inactivity.

[27] Sherman, in his march from Atlanta to Savannah alone, destroyed more than $400,000,000. The cotton famine occasioned by this war cost Great Britain a loss of $480,000,000. Who has ever thought of charging this against militarism?

[28] See E. Reclus, Nouvelle geographie universelle (French edition), vol. xvi, p. 810.

[29] A justification of this figure may be found in my Luttes entre les sociétés humaines, p. 220.

[30] A half million negroes are massacred every year in Africa in the tribal wars, which also are caused by the ctesohedonic fallacy. Suppose each one of them might have earned $20 a year. Capitalized at four per cent, this sum would have amounted to $400,000,000.

[31] See my Luttes, p. 228. Let us say, in passing, that we owe our existing savagery partly to the ctesohedonic fallacy. When we think that the most rapid way of enriching ourselves is by seizing our neighbor's territories, the fewer defenders that territory has, the better. So all pretended political geniuses glorify themselves on having killed the largest number of their fellow-men. Cæsar boasted of having killed a million and a half of Gauls. At the moment of writing these lines a terrible accident has occurred at Santander. Hundreds of persons were killed by the explosion of a boat loaded with dynamite. Great pity was expressed for the victims. Collections for their benefit were taken in France. Suppose France and Spain were now at war. If somebody had blown up some thousand Spaniards in a fortress, we should have sung *Te Deums*. Oh, man's logic!

[32] An address delivered at the Royal College of Science on October 6, 1898.

[33] Perkin. Nature, vol. xxxii, p. 334.

[34] Ch. Letourneau. Alphabet Forms in Megalithic Inscriptions. Bulletin of the Society of Anthropology, 1893.

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Transcriber's Notes:

Obvious printer's errors have been repaired, other inconsistent spellings have been kept, including inconsistent use of hyphen (e.g. "text book" and "text-book").

Illustrations were relocated to correspond to their references in the text.

Pg 568, year assumed in sentence "...Report for the Fiscal Year ended June 30, 1898..." as the original is unclear.