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APPLETONS'
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MONTHLY.

FEBRUARY, 1900.

SOUTH SEA BUBBLES IN SCIENCE.

By Prof. JOHN TROWBRIDGE,
DIRECTOR OF JEFFERSON PHYSICAL LABORATORY, HARVARD UNIVERSITY.

The advances in science lead to hopes of the sudden accumulation of gold, just as the discovery of new worlds led our ancestors to invest in many inflated enterprises of commerce and conquest. This older temptation has passed away, for there are no new worlds to discover, and this small globe has been practically staked out; but the mysterious domains of science are still illimitable, and afford vast opportunities for inflated schemes which have their prototype in the South Sea Bubble.

Let us refresh our memory of this surprising delusion. It arose in the reign of Queen Anne, nearly one hundred and eighty years ago, and when we consider the extent of the speculation and gambling which it caused and the number of those who lost everything and who consigned their families to bitter poverty, we are tempted to class it with those other calamities which preceded it and which afflicted England so heavily—the great fire of London and the plague. The South Sea Company claimed to have enormous sources of profit in certain exclusive privileges, obtained from the Spanish Government, for trading in their possessions in South America and Mexico; and it may be well for us in these times of the flotation of schemes for obtaining gold from salt water and from sands, of power from air and something more ethereal than air, to be reminded of the many bubbles that came into existence and burst at the time of the collapse of the South Sea Bubble.

The stock of the South Sea Company rose from one hundred to a thousand, and an army of future victims crowded the offices of the company, anxious to invest in what they believed would suddenly enrich them. 402
Indeed, all England seemed to go mad, and the craze of the time is reflected in the writings of Pope and Swift. Pope says:

“At length corruption like a general flood
Did deluge all; and avarice creeping on,
Spread like a low-born mist, and hid the sun.
Statesmen and patriots plied alike the stocks,
Peeress and butler shared alike the box;
And judges jobbed, and bishops bit the town,
And mighty dukes packed cards for half a crown;
Britain was sunk in lucre’s sordid charms.”

The rise of the great bubble was accompanied by the formation of hundreds of minor ones. Among these we will mention a few which are pertinent to the subject of this paper:

A wheel for perpetual motion. Capital, one million pounds.

For extracting silver from lead.

For the transmutation of quicksilver into a malleable fine metal.

Puckles Machine Company, for discharging round and square cannon balls and bullets, and making a total revolution in “the art of war.”

For carrying on an undertaking of great advantage, “but nobody to know what it is.”

It is estimated that the proposed capital for floating these and similar schemes was three hundred million pounds. We find, in the annals of the time, that the Duchess of Marlborough persuaded her husband, John Churchill, the great general, not to increase his holdings, and to sell his shares; he, like a sensible man, took a sensible woman’s advice and made one hundred thousand pounds. When we come to speak of the connection of women with modern delusions, we must remember this act of one of their sex.

At this time, nearly two hundred years after the singular outbreak of chimerical projects of Queen Anne’s reign, we can match some of these bubbles almost exactly; for have we not had the Keeley motor, the extraction of gold from salt water, and is there not great activity in making the wonder of the public over some advance in science a source of money-making? The unscientific person is certainly open to a new danger in the increasing tendency to promote enterprises based upon some new scientific discovery, and it behooves the followers of science to suggest a remedy for this growing evil. I shall endeavor to do my part in this paper in pointing out the necessity of some oracular medium—a scientific oracle of Delphos—to which the common man can repair and get trustworthy information, for it is a melancholy fact that such information can not be obtained from the 403
daily press or from the literary magazines of the time.

Many of our newspapers draw such an income from their advertising columns that the editors are unwilling to print any criticism which would lead to the restriction of this source of gain; thus if a company promoting a scientific bubble should advertise liberally in a leading newspaper, the editors are usually loath to insert an article upon the scheme, for the printing of the criticism might lead to the withdrawal of the advertisement. It is possible that the editors of such daily papers have not overmuch confidence in the judgment of scientific men, for have not the latter often been mistaken? There was Lardner, who prophesied that steamships could not cross the Atlantic, but we must remember that Lardner was not a scientific man; he was a popularizer of science, and never made a scientific investigation. It is said that there have been college professors who have denied the possibility of sending messages under the ocean. This I also doubt, for I am a witness in the flesh of the way such stories can arise. Not long since I was invited to speak before a commercial club, and the presiding officer, in introducing me, remarked: “The professor will now address you on the advances in electricity. When I was in college I well remember his describing an electric motor and his remark that it would never become a practical invention.” There was, of course, laughter, and the president sat down with a comfortable air of having made a point. The professor pointed out that the presiding officer graduated before he became professor in the university, and before the Gramme machine and the electric motor were invented.

Nevertheless, the world loves to believe in the inaccuracy of the accurate, and even a sophomore takes infinite delight in discovering arithmetical mistakes in an edition of Newton's *Principia*.

I mention this proneness to believe that scientific men are apt to be mistaken, for it is a blame laid at their doors often by the promoters of scientific bubbles, and for a very easily understood reason, and the editors of newspapers and literary magazines can ease their consciences after publishing sensational scientific articles by reflecting on the fallibility of the followers of science. Lawyers and judges, too, make their mistakes; nevertheless, we continue to resort to them for advice; and few editors, I imagine, would dare to publish a legal opinion without consulting an authority in law. Yet we read every day so-called scientific articles in newspapers and magazines which have evidently never been submitted to competent critics. Have we not read statements of the possibility of exploding powder magazines on board ships by electric waves; of the manufacture of liquid air without the expenditure of energy; of electricity direct from coal; papers on the nebular theory, more nebulous 404 than any nebula yet discovered? When we read a broad sheet in the morning paper setting forth a glowing scheme to manufacture power out of nothing, to what oracle can we repair to ascertain the truth? It is true that common sense might lead the reader to reflect that when he is told that the shares can now be obtained for five dollars, but in a short time they will be advanced to ten dollars, and now is the time to invest, that such good things are quickly taken up without the necessity of advertising. When the morning mail brings a prospectus of a company formed to make diamonds by electricity, a company with ten million dollars capital (why not one hundred millions?), to whom should one go to allay the fever of sudden gain? While men and women will carefully consider which line of steamships to Europe is the best equipped with engines, the efficiency of which depends upon the laws that prove the impossibility of perpetual motion, they enter at the same time upon schemes to obtain power without the consumption of work.

We are indeed confronted with the curious fact that even so-called intelligent people can be led to believe that what we have learned in regard to the working of Nature may be thrown aside, and that some new and unrelated laws may rule supreme. Thus we have what is called Christian Science, one of the intuitional sciences which may be said to add a new peril to matrimony. We find cultivated men believing that a government can make money by pronouncing silver equal to gold. Thus there are those who fondle their delusions and those who bank upon credulity. Education seems to be ineffectual with some temperaments; on the whole, however, it has a saving grace, and there are undoubtedly a number in the community who would welcome a source of scientific authority which might answer for them just as the Times does in political and economic questions to an Englishman. The American has especial reason to fear scientific bubbles, for our patent laws make it comparatively easy for promoters to make a great show of vested rights. One method is to build an imposing plant, with powerful dynamos and with a multiplicity of electrical devices, and to capitalize for an enormous sum an expensive plant in sight with millions in patents of very little value. The proposed investor is taken to see the great plant; its magnitude appeals to his reverence for size, and his pocketbook is soon at the service of the promoter. Another method is to select some scheme which is on the borderland between physics and chemistry, such as the electrolytic method of obtaining gold from salt water. There is a minute quantity of gold in salt water, and the chemist, thinking that electricity might afford an economical method of treating large 405 quantities of water, is reticent in regard to such a scheme, while the electrician, ignorant of chemistry, is ready to concede that the chemists may have found a cheap extractor, so the promoter can play the chemist against the electrician, and there is no arbitrator in sight. The American is peculiarly in peril from the absence of a large body of men trained in technical science, such as exist in Germany. He also has been unduly excited, and his desire for love of sudden wealth stimulated by phenomenal successes. The commercial triumph of the telephone has led to a multitude of scientific bubbles, and has resulted, like the discovery of gold in the Klondike, in a rush into electrical schemes which have been held up to a hungry crowd of victims as second only to the Bell telephone.

While the telegraph and the telephone can prevent speculations like the South Sea Bubble in a great measure, for such schemes were much aided by a lack of a general dissemination of intelligence, and this lack is supplied by a quick interchange of knowledge, they bring their own peculiar peril, for they are examples of what profit may be reaped from discovery in the world of science. The commercial enterprises of the world have been brought within reach of the many by the telegraph and telephone. They no longer belong to the few, while the successful working of the field of science is still confined to a minority and the general public; even the cultivated people are very ignorant of the approaches to the New El Dorado. No bogus land scheme or salted mining enterprise can be kept in existence to-day for a long period; but the Keeley motor, with its ethereal vibrations and its pseudo-molecular motions, was limited in activity only by the life of the promoter. Instead of the alchemists we have the seekers after power, which costs nothing, and in the train of the honest inventor there are unscrupulous promoters ready to capitalize any remarkable new fact or discovery which attracts public attention.

I have mentioned the influence of the first Duchess of Marlborough in inducing her husband, the great duke, to sell out his shares in the South Sea Bubble when they had risen to a high value because this example of discrimination and prudence in a woman supports one in the belief that all women are not prone to invest in women's bank schemes, in Keeley motors, or in enterprises for "carrying on an undertaking of great advantage, but nobody to know what it is." One of my friends recently visited the office of a company which proposed to produce power without the expenditure of a due amount of energy, and found among those anxious to invest a woman who said that she had just received a dividend from the company for extracting gold from salt water, and she was anxious to invest it in the new power company. The dividend was the result of a liquidation of the 406 Gold from Sea Water Company, and represented half of her original sum. She had come out of one delusion with a loss of half of her property, and was now ready to enter another one with the remaining half. It was an old-fashioned notion that women should be kept in ignorance of business, for business knowledge, it was thought, was the concern of the husbands. This notion prevails still in some quarters, and there may be some connection between the number of women in Christian Science temples and their lack of education in practical matters, or in what may be called the legal business habit—a habit which weighs the probabilities of this and that, and leads to ways of exact thinking.

One of the remedies for this proneness of women to invest in scientific bubbles, to invest money on faith, is the lack of exact training, which is not acquired by them either in private schools or colleges. The classes of philosophy and psychology in women’s colleges are crowded, while those in the exact sciences have only handfuls. This remark also applies to the students in men’s colleges, and we realize in this respect how closely college women imitate college men. They follow the latter also in the habit of taking lecture courses, a custom which increases vagueness, inaccuracy of thought, and looseness of statement. This choice of studies by the young women in their colleges is a serious question for mankind, in view of the speculative spirit which the feminine sex show toward scientific bubbles and schemes which promise an inordinate rate of interest; for the graduates of these colleges will become teachers of youth, and if not teachers they have an influence upon the coming citizen during his formative period. As teachers they will far outnumber men teachers, and they are fast coming into competition with men also in the routine of business offices and in certain positions in commercial houses. In these activities they will need a balance of judgment, exactness of thought, and business habits. They should be given a sufficient knowledge of the elements of physical science to know that power can not be created from nothing, and that the great mass of our knowledge of mechanics and of the relation of electricity to mechanics can not be overturned by any new discovery. Whatever is discovered must be related to what has preceded it. This is a characteristic of a science, and this is what distinguishes it from a delusion—namely, the great body of related facts put upon a mechanical basis, so that any fact can be substantiated and any phenomenon repeated. When this latter test is applied to many of the isms of the day they fade into thin air, and young women need especially to be taught to apply such a test. It would seem as if the present choice of study 407 by women students tended to intensify vagueness of thought rather than to correct it, to keep them in ignorance of business habits rather than to educate them in the balance of judgment on economic questions.

Women are born speculators, and are peculiarly prone to invest money and heart in bubbles. Being the power behind the throne, they can carry men into action, and it seems to me that especial attention should be paid in women’s colleges to the studies that cultivate accurate thought and business methods. A certain amount of the study of scientific methods and a study of common law might take the place of the study of philosophy, psychology, and biology, certainly in the first years of a woman’s college course, for psychology and biology are studies which demand long scientific training and maturity of thought. Recently I heard the following conversation at a bank in Cambridge. The cashier was speaking with a young lady: “Miss ——, your friend has overdrawn her account three hundred dollars, and you say she has left Cambridge.” “Yes, the trouble with Jane is she is too much educated.” A long residence in a university town makes one wary of educational theories, but the proneness of women to invest in women’s banks and bogus trust companies certainly seems to need a corrective in a new college curriculum. Men can indulge in delusions and can recover mental balance, and perhaps their fortunes; but women are apt to become bankrupt permanently. Their experience in business delusions is similar to that in affairs of the heart. Washington Irving says of this feminine attribute:

“She sends forth her sympathies on adventure; she embarks her whole soul in the traffic of affection, and if shipwrecked her case is hopeless, for it is a bankruptcy of the heart.”

More mathematics and science, and less philosophy and psychology, might correct that vagueness of thought which leads both men and women into delusion.

Now for our other remedies. Shall we have an academy which shall issue storm warnings of scientific bubbles? I fear that the influence of academies is waning, and that the conviction that there are as many good men outside of the academy as inside would militate against their dicta. We could have courts of scientific appeal, with judges appointed by the State to sit on scientific questions of perplexity, and to sift expert opinions. Such a constitution of scientific courts might be a good thing in several ways—a saving health to the public. The college professor would certainly be greatly relieved of endeavors of promoters to use the name and reputation of the professor’s university, and incidentally the little his own name might add. This remedial solution is not in sight, and we must direct our vision in another direction. We know that the newspaper can not serve us, for we 408 seek to kill sensations, and it seeks to live on them. We are bound to turn to some journal or periodical which will publish only what it considers sound science and will eschew sensational science; a journal which, just as the London Times is regarded as the authority on political and economical questions, will be looked up to as an authority on matters of science.

In order, therefore, to protect the public against scientific bubbles we must impress upon both men and women the fact that an education in science is desirable, and is becoming more important as the world grows older; but until a scientific education becomes more general, it is important that there should be some scientific oracle of Delphos, and I can not think of any better than a well-managed scientific journal, the editors of which will seek for the best information on scientific questions which interest the financial world. When it is known that such a journal admits to its pages nothing that is sensational, when it is realized that the best specialists contribute to it, surely it will become a saving help in times of trouble.

WHAT MAKES THE TROLLEY CAR GO.

By WILLIAM BAXTER, Jr., C. E.

Note.—The illustrations of railway generator and switchboard were made from photographs kindly furnished by the Westinghouse Electric and Manufacturing Company.

For the photographs of the electric truck and car controller we are indebted to the courtesy of the General Electric Company.

II.

If the successful operation of a street-railway car by mechanical power depended wholly upon the ability to produce a motor of sufficient capacity to do the work, the problem would be an easy one to solve, and would have been solved long before the advent of the electric motor. Mere ability to furnish the necessary power, however, is not enough to meet the requirements. As already shown, the mechanism must be light, strong, compact, simple, and so well protected that it can not be injured except under abnormal conditions. In addition, speed-controlling devices must be provided whereby the velocity may be changed at will and in the shortest possible time, and with as nearly absolute precision as possible. This controlling mechanism must also be so arranged that the direction of motion may be varied with the greatest certainty and as rapidly as may at any time be required. The way in which these results are accomplished in an electrically operated car can be 409
understood from Figs. 18 and 19, which are line drawings, in a simplified form, of an ordinary trolley car. Fig. 18 is an elevation showing the outline of the car body and the wheels in broken lines, while the motors and the wires through which the current is conveyed thereto are drawn in solid lines. Fig. 19 is a plan in which the outline of the car floor and the platforms is represented in broken lines, the solid lines being the motors and connecting wires.

In almost every instance railway cars are provided with two motors, as shown at *M M* in these two figures. This arrangement is adopted not because one motor can not furnish all the power required, but simply for the purpose of making the equipment more reliable. Everything of human make is liable to fail; hence if only one motor were used there would be more or less liability of its giving out at a critical moment, and then the car would be helpless. If two motors are provided, should one give out the car would not be disabled, for the remaining machine would be able to run it to its destination. In order that this result may be successfully accomplished, each motor is made of sufficient capacity to run the car without being overtaxed, unless the load is abnormally large; but even under the latter conditions the machine will in ninety-nine cases out of a hundred withstand the strain. Some roads, in small towns, where the traffic is light and the expense must be kept down to the lowest point, use single-motor cars, so as to effect a saving in first cost. This course, however, is very seldom followed, except in places where there are no heavy grades or where there is very little probability of the loads becoming excessive, except at rare intervals. If the cars are provided with a single motor, when one becomes disabled from any cause it has to wait until overtaken by the car behind it, so that it may be pushed by the latter to the end of the road.

The electric current for operating the motors is generated in a power house that is located at some convenient point along the route. The current is conveyed to the moving cars by means of a trolley wire, which is marked *T* in the drawings. Unless the road is very small and operates but a few cars, this wire will not be sufficient to carry all the current, hence in most cases there are a number of supplementary wires, which are called feeders. These wires are carried along on poles, and at proper intervals are connected with the trolley wire *T*. The electric current passes from the trolley wire through the motors on the car, and thence to the rails *R*, and through these, and also through the ground, back to the power house. The exact path of the current is as follows:

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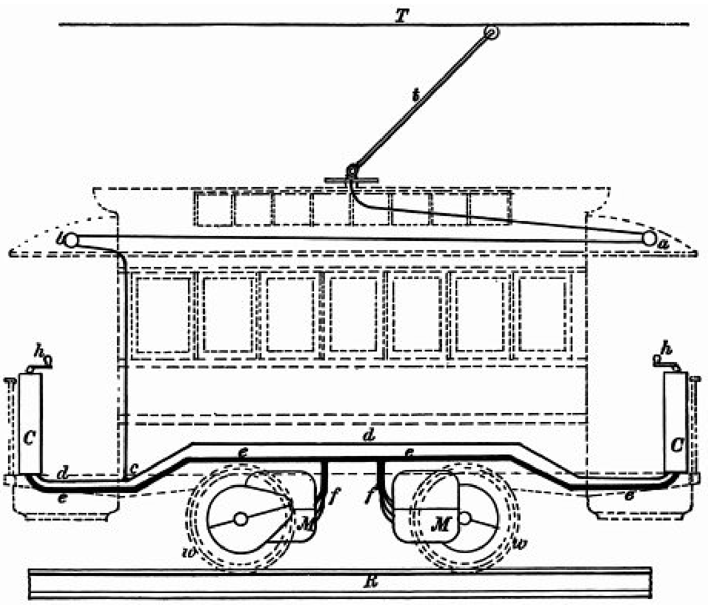

Fig. 18.

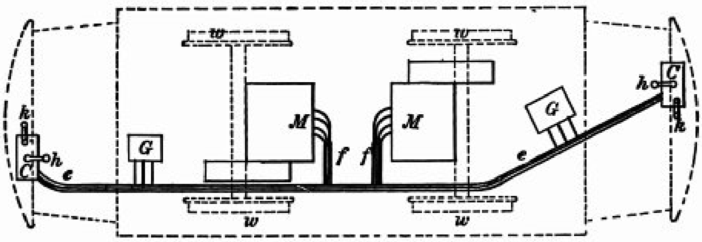

Fig. 19.

Figs. 18, 19.—Outline Elevation and Plan of Electric Railway Car, showing Location of Motors, Controlling Switches, and Connecting Wires.

From the trolley wire, through the trolley pole *t*, to the fixture on top of the car which holds the latter. From this fixture, as shown by the heavy full line, the current passes to *a*, which is a switch located under the car hood overhanging the platform. From this switch the current passes to a similar one, marked *b*, located in a like position at the other end of the car. These two switches are called emergency switches; they are provided simply as a safety device, and are used only when the main switches get out of order and the motorman can not turn the current off in the regular way. From the last hood switch *b* the current passes to the bottom of the car, 411 where it enters the wire *d d* at the point *c*. This wire *d d*, as will be seen, runs in both directions, and ends in the stands *C C*. These latter are the controlling switches, and are provided with a handle *h*, by means of which the current is turned on or off from the motors, and is directed through them in such a way as to make the car run in whichever direction may be desired. From the controllers *C C* several wires are run under the car, as shown at *e e e*. These wires are generally bunched into one or two cables, but they are kept separate from each other by means of strong insulating coverings. Four wires lead into each motor, and three or four into each of the boxes marked *G G*. If the motors were required to run in one direction only, then two wires would be sufficient to convey the current to them; but as they have to run in either direction, at least three wires are necessary, but in almost every case four are used, as the results obtained thereby are more satisfactory. The boxes *G G* are called rheostats, and are simply devices through which the current is run so as to reduce the speed of the car, and also for the purpose of graduating the strength of the current that passes through the motors in the act of starting. These rheostats are very seldom in use when the car is in motion, because it is a waste of power to pass the current through them. After the current has passed through the motors it enters the ironwork, and thus gets into the car wheels and finally to the track.

The lines drawn in Fig. 18 to indicate the position of the wires in the car do not show their actual position, but only the general direction they follow. From the trolley base to the first hood switch the wire, as a rule, is run along the car roof on one side of the ventilator, and the wire leading from the first to the second hood switch occupies a corresponding position on the opposite side of the roof. From the last hood switch, *b*, the wire is run down one corner of the car body, being either within the car body, or, if not, so covered by moldings as to not be reached by the hands of passengers. The wires *d* and *e* are generally run under the car, and are firmly secured to it by means of suitable fastenings.

The controlling switches *C C* are provided with one and sometimes two handles, one of which is used to regulate the speed of the car and stop and start it, while the other is for the purpose of reversing the direction in which it runs. The handle *h* is for the purpose of regulating the speed, and by means of *k* the direction of motion is changed. Before *h* is moved from the inactive position *k* is turned so that the car may run either forward or backward, as may be desired; then, when *h* is moved, the car will start, and by varying the position of *h* the speed can be changed. If it is desired to reverse the car, *h* is brought back to the stop position, *k* is 412 shifted to the reverse motion, and then *h* is again turned to the running position. When the controlling switch is provided with only one handle this is turned in one direction to run the car ahead, and in the opposite direction to run it backward, the graduations in velocity being obtained by placing the handle in positions intermediate between the stop position and the highest speed position.

As will be noticed, the wire *d d* branches at *c* and runs in both directions. Now, when the controller handles are both turned to the stop position the current from the trolley can get no farther than the ends of *d* in either switch, but if one of them is turned to the running position, the current at once passes to the wires in the cable *e e e*, and thus to the two motors. If the switches *C C* are in proper working order and there is no disarrangement of the wires leading to the motors or those within the latter, the current will obey the movements of the handle *h*, but under other conditions it may not. If such an emergency arises, the motorman reaches up to the hood and turns the safety switch *a* or *b*, and thus cuts the current off.

The force with which the motors turn the car wheels around depends upon the strength of the current; this is owing to the fact that the magnetic force is increased or decreased by variations in the current strength. If the current is doubled the magnetic force of the armature is nearly doubled, and so is that of the field magnet, therefore the pull between the poles is nearly four times as great. From this it will be seen that the force with which the car is pushed ahead can be increased enormously by a comparatively small increase in the strength of the current. If the current strength is doubled, the propelling force is practically quadrupled; and if the current is increased four times, the propelling force is made nearly sixteen times as great.

The speed at which the car runs depends upon the force that impels the current through the wire, and which is called electro-motive force. The greater the electro-motive force, the higher the velocity. If the current passes from the wires in the cable *e e e* through each motor separately, and thence to the rails *R*, each machine will receive the effect of the whole electro-motive force of the current; but if after the current has passed through one motor it is directed through the other, then each machine will be acted upon by only one half the electro-motive force, and, as can be seen at once, the velocity in the first instance will be twice as great as in the last. This fact is taken advantage of in regulating the speed of the car, and controlling switches arranged so as to direct the current through the motors in this way are designated as belonging to the series parallel type, the 413
name being given from the fact that when the car is running slow, the current passes through the two motors in series—that is, through one after the other; but when the motors are running fast, a separate current passes through each machine.

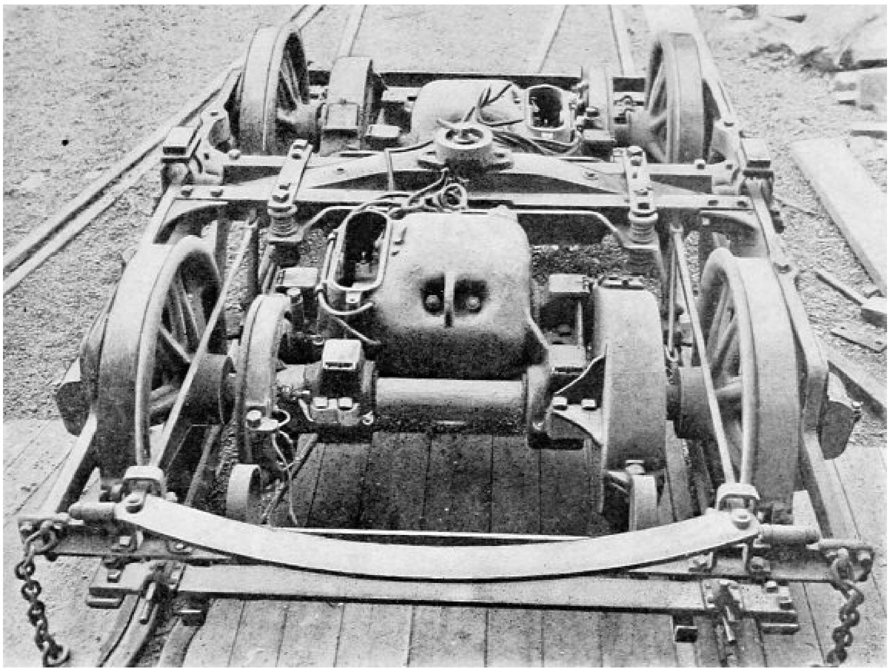

Fig. 20.—View of Electric Railway Truck with One Motor on each Axle and provided with Magnetic Brakes.

If, when a car is running, the controlling switch is turned to cut the current off, the effect will be that the speed will gradually reduce; but if it is desired to effect a sudden stop, it becomes necessary to check the headway by means of a brake. For this purpose the hand brake ordinarily used on all types of cars is employed, but magnetic brakes are also used in some cases. Fig. 20 shows a car truck equipped with two motors and magnetic brakes, one on each axle. Looking at the front end of the truck, the brake is seen on the left side of the axle, between the motor bearing and the car wheel. The larger drum, on the right side, is the casing within which the gear wheel and pinion are inclosed. These magnetic brakes are operated by a current generated by the motors, and not by that of the main line. As was explained in the first article, an electric motor can be made to act as a generator of electric current by simply reversing the direction in which the armature revolves. If we do not desire to reverse the direction of rotation, the result can still be attained by reversing the direction in which the current passes through the armature coils. It is evident that the direction of a car motor can not be 414
reversed at the instant that it is desired to have it act as a generator—that is, when it is desired to put the brakes on; hence the direction of the current through the armature is reversed.

When a car is provided with magnetic brakes, the controlling switches are so made that when the handle *h* is moved back to the stop position it disconnects the motors from the trolley wire and at the same time connects them with the magnetic brakes in such a manner that they will act as generators and thus send current through the coils of the latter. In order that the force with which the brakes are applied may be graduated, the controlling switches are arranged so as to be moved several steps back of the point which in the ordinary type of switch would be the final stop position. When the handle *h* is placed on the first brake position the current generated by the motors is not very strong, and as a consequence the force of the brake is light, but sufficient to bring the car to a stop in a reasonable distance. If a quicker stop is desired the handle is moved to the second, third, or fourth brake position, thus increasing the retarding force as much as may be desired. Magnetic brakes are very desirable, as they save the car wheels, and furthermore afford an additional safety in cases where it is necessary to arrest the speed instantly.

The position of the motors with reference to the truck and car wheels is very well shown in Fig. 20, and also the manner in which they are held in place. The covers of the openings through which access to the commutator brushes is obtained are removed from both motors, and in the forward one the top of the commutator and one of the brushes can be readily seen. The manner in which the motors are suspended from the truck is not the same in this figure as in those previously shown, but this is simply because the machines are not made by the same concern, and each manufacturer has his own design.

Fig. 21 shows the appearance of the interior of the controlling switches *C C*, Figs. 18 and 19. It will be noticed that there are two upright shafts, the ends of which project above the top of the box. The handle *h* is placed upon the shaft to the left, and *k* on that to the right. The first is the main controller, and the other is the reversing switch. It will be noticed that the main controller shaft carries a number of circular segments of different lengths; these are so disposed that they come in contact with suitable stationary pieces as the handle *h* is turned around, and thus vary the path of the current through the motors and the rheostats in the manner required to effect the desired changes in the velocity of the car. The reversing shaft is also provided with a 415
number of segments, but these are not so easily seen, although they can be discerned on close examination. The wires from the cable *e e e* and also wire *d d* are attached to the stationary pieces with which the segments carried by the two shafts make contact when the latter are moved around by the motorman. These wires can be seen back of the main switch shaft, and also above the board located at the lower left-hand corner. All these wires enter the controller through an opening in the bottom.

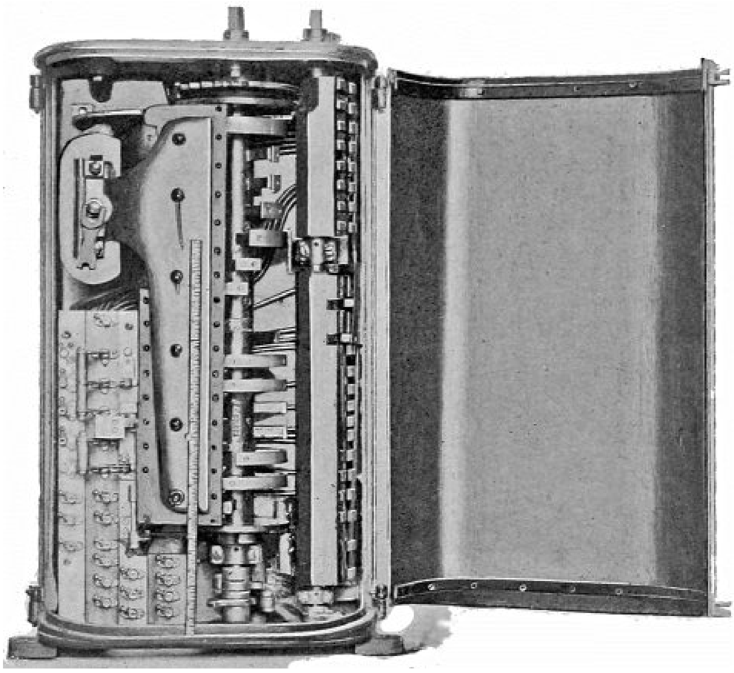

Fig. 21.—View of Interior of Car Controller.

In addition to the apparatus shown in Figs. 18 to 21, electric cars are provided with a safety fuse and a lightning arrester, the object of the latter being to protect the motors from the destructive effects of lightning strokes. The object of the safety fuse is to protect the motor from injury when the current becomes too strong. An electric current in passing through a wire generates heat, and the stronger the current the greater the heat. If the wire is large and the current weak, the heat developed may be insufficient to raise the temperature to a noticeable degree; but, on the other hand, if the wire is small or the current very strong, the heat generated may be capable of raising the temperature of the metal to the fusing point. In fact, the incandescent lamp operates upon this principle; the carbon filament is traversed by a current of a strength sufficient to heat it to a point where it becomes intensely luminous, and sometimes, through accident or otherwise, the current becomes 416
strong enough to melt the filament, and then the light goes out. In an electric motor it is not necessary to raise the temperature of the wire to the melting point to do serious injury; in fact, if the heat is sufficient to char paper or cloth, the machine will be rendered useless until suitable repairs are made. The insulation of the wire coils is made principally of cotton, which is a very good electrical insulator in its natural state, but when carbonized by excessive heat it becomes a conductor. As soon as it becomes a conductor the current is no longer confined to the proper channel, but cuts through the insulation to find the shortest path through the machine. If safety fuses were not provided the danger of destroying the insulation of the motors and thus disabling the car would be decidedly great, for, as already said, the motors can not be stalled with an overload, the only effect produced being a reduction in the speed and an increase in current strength. Now, if there were no way of limiting the increase in current strength the motors, if greatly overloaded, would continue to operate until the insulation gave out. The safety fuse is simply a piece of wire of such size that it will be melted by a

current that the motors can carry without being injured; hence when the current strength reaches a point where the safety of the apparatus is endangered the fuse melts and thus breaks the circuit and stops the further flow of current. Fuses are generally made of an alloy that melts at a low temperature, so that the molten metal may not set fire to anything upon which it may fall. These easily fused alloys are inferior to copper as electrical conductors, and on this account the fuse wire is as a rule much larger than that wound upon the motors, which fact makes its action somewhat mysterious to the uninitiated; but whatever its size may be, it is so proportioned that it will melt before the current rises to a strength that would injure the motor coils.

The manner in which the electric current generated in the power house reaches the motors is illustrated in Fig. 22. In this figure four tracks are shown, which may be taken to represent roads running in as many different directions. The three squares at the left side represent generators located in the power house. The circles *a a a* represent switches, by means of which the generators are connected or disconnected from the trolley lines. *A* and *B* represent heavy metallic rods, generally made of copper, with which the generators are connected by means of the switches *a a a*. These rods are called bus bars. The circles *b b b b* represent switches by means of which the current is turned on or off from the several tracks.

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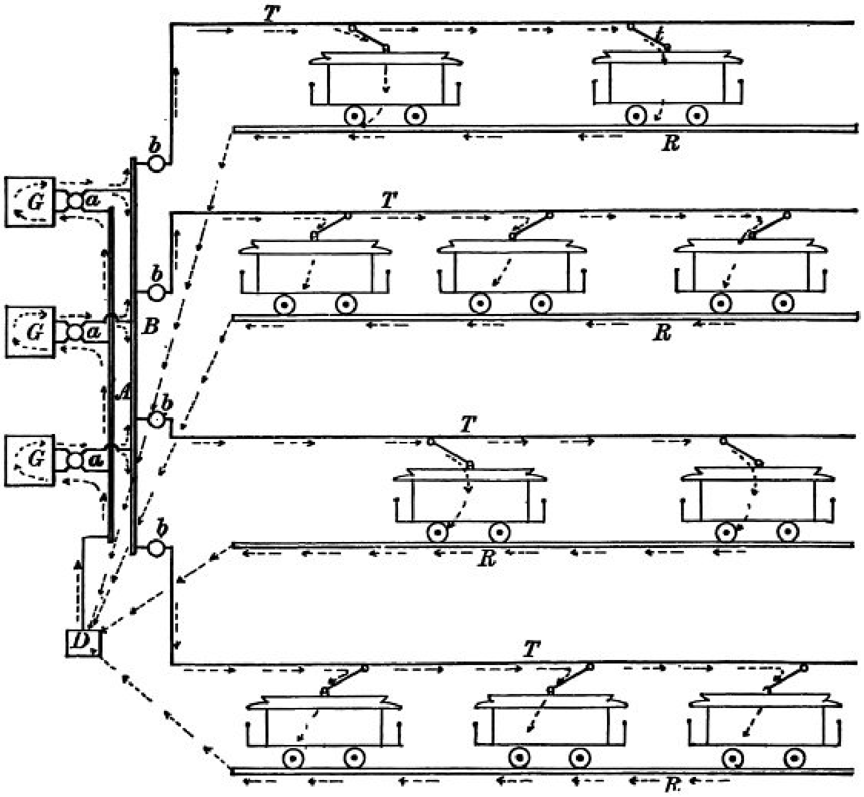

Fig. 22.—Diagram illustrating the Manner in which the Electric Current flows from the Generators to the Cars upon the Tracks.

Electric currents must always circulate in closed paths—that is, the current that starts out from a generator must return to it, and the amount coming back is the same as that which leaves. The action of an electric generator can be understood by comparing it with that of a water pump pumping into a pipe which runs around from the delivery end to the suction. With such an arrangement it can be seen that the action of the pump would be to keep the water in circulation, but the same water would be pumped through the pump and the pipe all the time. With an electric generator the action is the same, and in Fig. 22 the current flowing along any one of the tracks follows the course indicated by the arrows. The currents pass out to the several tracks through the trolley wires *T T T T*, and return through the tracks *R R R R*. The bus bar *A* is connected with a plate *D*, which is imbedded in the ground, and is also connected with the ends of the rails *R R R R*. Suppose for a moment that the two lower generators are out of service, their switches *a a* being turned so as to disconnect them from the bus *A*, and, further, suppose that the three lower *b* switches are open, so that the current can only pass to the 418 upper track; then the top generator will feed into the top road only. Tracing the path of the current under these conditions, we find that it will start from the upper side of the generator through the *a* switch to the *B* bus, and thence to the trolley wire at the top of the figure. On reaching the first car a portion of the current passes to the track *R*, the amount being dependent upon the speed of the car and the load. Why the whole current does not follow this path generally puzzles the layman, but the explanation is that the motors hold the current back, and only allow as much to pass through them as is necessary to perform the required work—that is to say, the current flowing through each car is not controlled by the generator or by the force of the current, but by the requirements of the motors. The amount of current delivered by the generator is governed by the demands of the motors. The current that does not pass through the first car goes on to the second one, and if there were more cars there would be current left in the trolley wire to supply them. After passing through the motors of the two cars the current returns through the rails *R* to the plate *D*, and thus to bus *A*, from which it enters the lower side of the top generator. It will from this explanation be seen that the action of the generator is simply to keep the current circulating. If two of the generators are connected with the bus bars *A* and *B*, the current required by the motors will be delivered by the two machines, and if the three generators are placed in service the current will be divided among them.

When two or more generators are used, it is necessary to provide means to prevent the current from dividing unequally between them; if this were not done, one machine might do nearly all the work, while the other one would be practically idle. The means employed to accomplish the result is simply an additional bus bar, which is called an equalizing bus. We will not undertake to explain the principle upon which this arrangement acts; it is sufficient to say that by such means the work can be distributed in amounts directly proportional to the capacity of the generators, so that if one machine is very much larger than the others it will take a portion of the load corresponding to its size. In order that these results may be attained it is necessary to properly adjust the several generators, and as no machine can be made to work with the accuracy of perfection, the work will not be distributed in true proportion for all conditions of load; thus if the generators are adjusted so as to each take its proper share when all the cars are in operation, one machine may do too much or not enough when only one half the number are running, but the excess or deficiency will not be more than a few per cent unless the adjustment is very defective.

Electric generators for railway work are made in all sizes, from those only large enough to operate four or 419
five cars to others capable of furnishing sufficient current for thirty or forty or even more. Small generators are made so as to be driven by a belt running over a pulley mounted on the end of the armature shaft, or they may be arranged to be connected to the end of a steam-engine shaft, and thus become what is called direct connected machines. Large generators are almost invariably of the latter type. A machine of this class is illustrated in Fig. 23. The driving engine is shown at *E*, the cylinder being in the background and the crank toward the front, the shaft being clearly seen at *S*, while *F* is the fly wheel. The generator is mounted directly upon the engine shaft, between the bearing at the crank end and the fly wheel. The large ring marked *G* is the field magnet ring, and at *D D D* the field coils are shown. These coils are equally spaced all the way around the circle. The commutator is marked *C*, and the commutator brushes are located at *B B*. The armature can not be seen very well, as it is covered by the brush holders and their supporting frames, but it is located within the ring *G* in the position designated by *A*. This machine is one of a number used to operate the roads of Troy, N. Y., and is of about one-thousand-horsepower capacity, which is enough to furnish all the current required to run sixty or seventy cars.

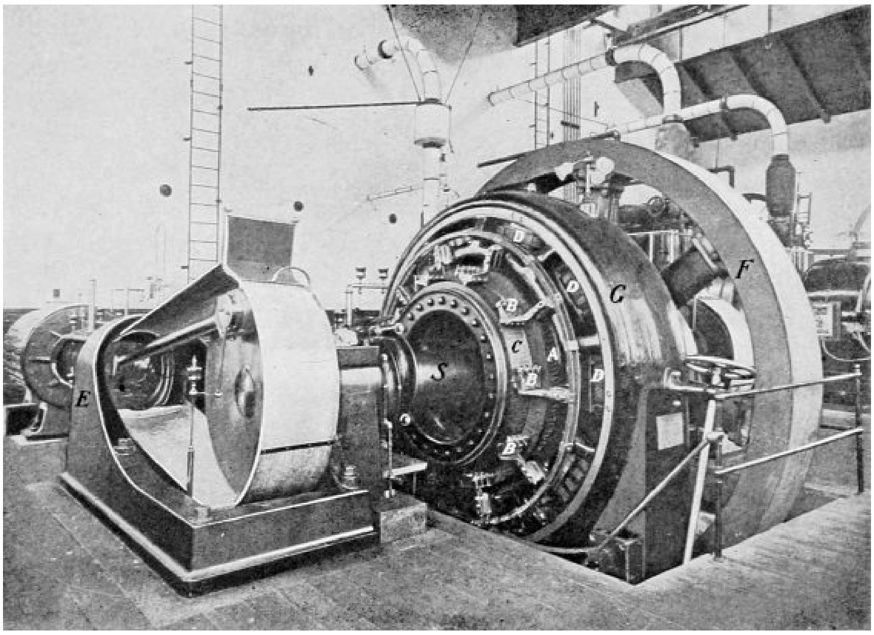

Fig. 23.—Large-Size Direct connected Electric Railway Generator.

The switches *a a* and *b b*, shown in Fig. 22, and the bus bars *A B*, are mounted upon a large panel, made of 420
marble or slate, called a switch board. These switches are sufficient for the purpose of turning the current on or off any track or for connecting and disconnecting the generators, but for the successful operation of the plant it is necessary to have other devices by means of which the strength of the current may be ascertained, and also the electro-motive force. It is necessary to provide each generator with means for varying the electro-motive force of the current it generates, otherwise the load could not be properly equalized between the several machines. All these different devices are located upon the switch board, so as to have them in an accessible position. A railway switch board, arranged for four generators and a large number of distributing circuits, is shown in Fig. 24. The four generator switches are shown at *a a a a*, and the circles marked *R*, directly under them, are the devices by means of which the electro-motive force of the current is regulated. These devices are called field regulators, from the fact that their office is to regulate the strength of the field magnets of the generators, making them stronger to increase the electro-motive force and weaker to reduce it. The part seen upon the front of the switch board is not the regulator proper, but only the handle and the contact points over which this swings. The instruments marked *A A A A* are for measuring the strength of the current of each individual generator, and are called ammeters. The instruments marked *V V V V* are for the purpose of indicating the electro-motive force of the currents of the several generators, and are called voltmeters. *Ag* is an ammeter used to measure the strength of the total current, and *Vg* is a voltmeter that indicates the electro-motive force of the current passing out to the cars on the various lines. The ammeter *Ag* is not an actual necessity, for the strength of the total current can be ascertained by adding the readings of the four instruments connected with the generators, but it is a convenience, as it saves the trouble of performing the addition. The voltmeter *Vg*, however, can not be regarded in this light; in fact, its presence is decidedly

serviceable, for it indicates the average electro-motive force of all the generators; therefore if any one of the instruments *V V V V* is higher or lower it shows at once that the generator to which it is attached is out of adjustment and not doing its proper share of the work. The switches *b b b*, by means of which the current is turned on to the several external circuits, are shown at the extreme end of the switch board.

The instrument marked *W*, located between the *a* switches, is called a wattmeter, and its office is to indicate the amount of power furnished by the generators. This instrument is not always used, as it is a convenience but 421
not a necessity. It can be seen at once that whether it is used or not, the amount of power required to operate the roads will be the same, but it is thought by most railroad managers that it is desirable, for then the relation between the coal consumed and the power developed can be seen; and if the showing is not as good as it should be, the engineer can remind the firemen that they are not exercising as much care in feeding the boilers as they should. Considered in this light, the watt-meter acts as a check to wastefulness on the part of the employees.

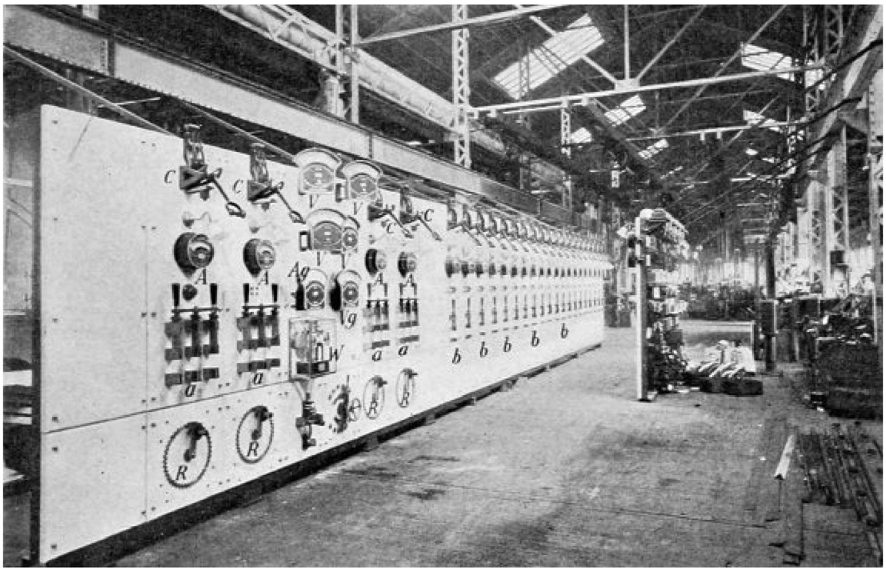

Fig. 24.—Electric Railway Switchboard.

The instruments marked *C C C C* serve the same purpose in connection with the generators as the safety fuses do with respect to the car motors; they are electro-magnetic devices used to open the generator circuits whenever the current reaches a strength that is sufficient to injure the machine. These devices are called circuit breakers. As will be noticed, there are four located directly above the four *a* switches, and, at the farther end of the board, a large number located directly above the *b* switches. The latter act to open the individual circuits when the currents flowing in them become too strong, and the former are controlled entirely by the current of the generator circuits. A circuit breaker is more reliable than a safety fuse, because it acts quicker. With the fuse the current must act for some time before it can melt the metal, as a sufficient amount of heat can not be generated instantly. With the circuit breaker, however, the action is instantaneous, for as soon as the current reaches the predetermined strength the magnetism of the operative parts of the device becomes sufficiently 422
strong to cause it to act. A circuit breaker is simply a switch that is arranged to be opened automatically by the action of a magnet, instead of by the hand of the operator. The switch part of the apparatus is held in place by a catch that is set much after the fashion of the catch in a mouse trap—that is, so that the least pressure will disengage it. A strong spring acts to throw the switch open, and as soon as the catch is tripped by the actuating magnet the force of the spring comes into action and the circuit is opened.

The circuit breaker is a very valuable apparatus, for it frequently happens that, through delays of one kind or another, a large number of cars concentrate at one point on the road, and, as all the motormen are anxious to make headway, they all start up at once at the first opportunity. If there were no circuit breakers at the power house the result would be that some of the generators would be greatly overloaded and perhaps disabled; but, owing to the presence of the circuit breakers, the actual result is that the circuit is broken, and then the motormen have to wait until the current is turned on again. If too many of them try to start their cars at the second trial the current will again stop. After two or three ineffectual efforts have been made to start all the cars together the motormen will conclude to go easy, and set a few in motion at a time. In this way the cars will become more evenly distributed along the line, and the demand for current at the point of blockade will reduce to the normal amount, or nearly so, and the running of the cars will continue without further interruption, for the current drawn by the motors having been reduced to the average amount, the circuit breaker will cease to act.

The bus bars and all the connections between them and the generators and external circuits, as well as with all the instruments, are located behind the switch board. All these connections are so secured that they can not come in contact with each other except where contacts are required; care is also taken to prevent any connection being made with the iron framing that supports the marble slabs. The front of a switch board is generally very attractive, the surface being of highly polished marble, while all the switches and instruments are finely finished and, as a rule, of decidedly ornamental design.

The switch board might be looked upon as the fountain head from which the entire operation of an electric railway system is controlled. By the movement of one set of switches upon it the generators are thrown in or out of service, and by the movement of another set of switches the several branches of the road are rendered active or inactive.

IS THE CHRISTIAN RELIGION DECLINING?

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The question whether the Christian religion is declining is agitating the public mind in some measure at the present time. This is due to the many changes that are taking place in the forms of religion, the types of doctrine, and the methods of action in the numerous religious organizations which bear the name of Jesus Christ. Are these changes symptoms of disease and decay in the Christian religion, or are they evidences of renewed vitality and enlargement by growth? It is quite evident that many things which have been regarded as important and even essential in the past have declined in importance, and some of them seem to be on the eve of disappearing altogether. It is not surprising that those who have been trained to regard these as essential to Christianity should think that the Christian religion is declining with them. If, however, these things are not so important as has been supposed, but have gained for a time an exaggerated importance, then their decline to their normal position and the advance of other things to their rightful place, as more important things than has hitherto been supposed—all this is evidence of a healthful advance in Christianity. This question, therefore, will be answered in accordance with the point of view of the one who considers it. If it is to be answered correctly we must put aside all prejudice, and examine the whole situation candidly and with a critical scientific spirit. It is impracticable within the bounds of this article to examine this question on all sides. We can only make a few suggestions relating to it.

It is necessary at the outset to approach the question aright. We must distinguish between what is essential to the Christian religion and what is non-essential. This is not so easy a task as one might imagine. We can only make this distinction generally, and not with scientific precision. In the study of religions we have to distinguish (1) the more fundamental things in the historical institutions and experience in life; (2) the doctrines which express the popular belief or scientific knowledge of the adherents of the religion; and (3) the expression of the religion in ethical principles and moral conduct. The order of development is always life, doctrine, morals. The earlier stages of the Christian religion and of Christian experience at any time and in any community is the vital experience and the institutional organization. Doctrines of faith and knowledge presuppose the vital relation, and morals presuppose both, and conduct is the final aim and crown of the whole development. And yet there 424
are some scholars who exaggerate the relative importance of each one of the three in its relation to the other two and to the whole.

In our age greater attention is given to Christian ethics and sociology than ever before. A man who has the ethical enthusiasm of our times is inclined to criticise historical Christianity with great severity, because of its failure to realize the highest ethical ideals, and especially those presented by Jesus in his teaching and his example. Historical Christianity is so far below these ideals, even in its best types, that one is inclined to say if the Church has failed so badly in nineteen centuries, what prospect has it in the present or the future? Some good men in our times are disgruntled with historical Christianity for its ethical failures, and keep aloof from the Church on that account; but these are after all proportionately few, and they are unreasonable, for they exaggerate the ethical phase of Christianity over against the doctrinal and the vital; they fail to see what is necessarily involved in the development of the Christian religion, that the ethical age should come last of all; and they also are not just in their estimate of Christian history, for, notwithstanding the failure of the Church, there has been a wonderful and steady ethical advance through the centuries. Indeed, it is Christianity itself which is chiefly responsible for the ethical enthusiasm of the present time, and this is an evidence that Christianity is about to enter upon the last and highest stage of its development. Holy love in principle and practice in the liberty of self-sacrifice is better understood in the Church to-day than ever before, and it is becoming more influential in the Church and in the world. The Church is about to put forth the supreme ethical influence of holy love to transform society and the lives of men.

In large sections of the Church the greatest stress is still laid upon Christian doctrine, especially as expressed in dogmatic forms. If a man thinks that orthodox doctrine is the test of a healthful and vigorous church, he will make that the determining element in his judgment whether Christianity is advancing or declining. In this sphere we have to distinguish three things: (1) The popular orthodoxy, which is determined by the consensus of teaching from the pulpit; (2) the scholarly orthodoxy, which is determined by the teaching of the theologian from the chairs of the theological schools and in text-books of dogmatic theology; (3) the official orthodoxy, which is determined by creeds, liturgies, confessions of faith, and canons of the Church.

There can be no doubt that there has been a great overturning of dogma in our times, and it is altogether
probable that this will assume much greater dimensions. Many think that dogma has had an exaggerated 425
importance in the past, and, from their point of view, the Christian religion has made an advance by pushing dogma back to a less dominant position. Those who maintain that dogma is of supreme importance naturally think that the Christian religion declines when dogma is discredited in the Christian community. There can be little doubt that a large number of men absent themselves from church attendance because they dislike the popular orthodoxy, which seems to them antiquated, unscientific, and untrue. Many refuse to unite with religious organizations which are dominated by an orthodoxy representing the theories of scholastic theology. Many remain apart from the churches because they are unwilling to be responsible in any way for their official orthodoxy. Many, born and trained in Presbyterian families, refuse to remain in an organization which is responsible for the hard doctrines set forth in the Westminster Confession. Many Methodists refuse to be compromised by Wesley’s doctrines and Wesley’s rules of life. Many refuse to remain Baptists because of what is involved in close communion. Many refuse to be Episcopalians because they resent the doctrines and practices of sacerdotalism. And so we could find, more or less in all religious communions, a dissatisfaction with dogmas—sometimes superficial, giving a plausible excuse for absence, sometimes profound, inciting active hostility to the Church. If all of these dissatisfied ones are to be regarded as hostile or indifferent to Christianity, then it is evident that an army of Christians have practically separated themselves from the Church in our time, and we must say that Christianity has in this respect declined. If, on the other hand, we think that

these dissatisfied and disgruntled ones are yet Christians, and that they are maintaining their faith in Christ in opposition to an unreasonable church, that they are exerting an important influence in the transformation of the dogmas of the Church, then we may say that this is an evidence that Christianity is in a state of transition, that it is on the move away from an untenable position of exaggerated dogma to a truer and stronger position, in which dogma will be transformed and given its normal place and importance.

The effort to throw off the bondage of the popular and the scholastic dogma is an advance, and not a decline; it is an advance into the realm of freedom. It first gives the possibility of a critical re-examination of the dogmatic faith of the Church. Only by the application of the scientific methods of our age to dogma is it possible for our age to verify dogma and accept it as valid and reliable. We can not rely on anything that is merely traditional or the product of the logical analysis of premises which remain themselves unverified. The revolt 426
against the confessional orthodoxy, especially in the Presbyterian, Reformed, and Lutheran Churches, is not a sign of decline, as some think, but a wholesome movement which indicates a determination to know the truth and to hold nothing but the truth.

The Chicago-Lambeth articles, adopted by the whole Anglican communion throughout the world, reduces the essential doctrines of Christ's Church to the Nicene Creed and the Apostles' Creed; those creeds in which all the great historical churches, the Greek and the Oriental, the Roman and the Protestant, agree. This marks a dogmatic advance, not a dogmatic decline, because it makes the distinction between the essential and unessential doctrines, it defines essential doctrines by holding up ancient fundamental historical creeds; it thereby represents all other matters as within the realm of the unessential doctrines, the province of Christian liberty.

The churches are therefore readjusting themselves in their relation to Christian doctrine, and the Christian community is readjusting itself likewise. The offensive features of Christian dogma, while still retained and advocated by some theologians and some communions, have been in great measure removed by other theologians and communions, and the process is going on with great rapidity. The war against science, criticism, literature, and art—all that is characteristic of our age—is gradually being limited to a smaller number of theologians and denominations, and there is ever an increasing number of theologians and churches which fully recognize all the achievements of modern times and who are at work in harmonizing them with the verified Christian dogmas in a larger, grander system—in a new theology representing all that is noblest and best in Christianity as applied to the modern world. While this process is going on, the dissatisfied ones will take some little time to find their new church homes and to adjust themselves to new conditions and circumstances.

So far as the great mass of mankind is concerned, the chief factor in the Christian religion is the fundamental one of the Christian life and the Christian institution, and the advance or decline of Christianity will be judged from this point of view. Here, however, we must recognize that there are several types of religious life which sometimes combine in one community, but which ordinarily exist apart as characteristic of different temperaments, different nations, different races. The lines of cleavage in historical Christianity are for the most part racial, national, or temperamental. We have to take this into account when we consider the 427
religious life and institutions of different countries. What a difference there is in religion from this point of view in the great centers, such as Rome, St. Petersburg, Berlin, London, Edinburgh, New York! That man would go far astray who should undertake to use any one of these as a test of any or of all the others.

Let us consider, for example, the question of participation in the services of the Church. Rome has apparently, from a Protestant point of view, an abnormal number of churches, and in these churches an extraordinary number of chapels and altars. The reason for this is that there is an immense number of clergy in Rome, and all these altars are needed that they may perform the most important of their duties—the sacrifice of the mass. The churches, chapels, and altars are not erected for the people merely—if so, vastly fewer would be necessary—but for the priests who sacrifice for the people even when they are absent. Berlin has apparently very few churches, and these are not always well attended by the people, and are used infrequently except on Sundays. Judging from this, it would be a very irreligious city; but any one who really knows Berlin would not say that it is less religious than Rome. The religion of the German people finds its expression in a mystic type of personal piety and of family and social life; it maintains and propagates itself without frequent attendance upon public worship.

In London regular attendance upon public worship is commonly regarded as indispensable for the maintenance of the Christian religion. Therefore Christian people frequent the churches to an extent that is unknown on the continent of Europe. But to make the British habit of frequenting the Church for public worship a test of the vitality of the Christian religion in the great cities of the Continent would be altogether unjust and untrue. The historical development of religion in Great Britain has brought about an entirely different state of affairs there from that which we find everywhere else in the world. The situation in Great Britain is therefore special, peculiar, and, one might say, abnormal as compared with the situation in other parts of the world. In the United States the original population was chiefly British, and therefore followed British methods in religion. But in the present century our land, and especially our cities, have filled up with a population from the continent of Europe, bringing with them Continental methods of worship which would not yield to or readily adopt British methods. Intermarriage with the British stock and familiar converse in society have tended to assimilation, and therefore the situation has gradually and inevitably emerged that the Christianity of New York and Chicago and our other great cities has assumed an intermediate position between that of the Continent and 428
that of Great Britain. The religious customs characteristic of British Christianity have undoubtedly declined—they have yielded to the influence of Continental Christianity. If British Christianity is the norm by which we are to judge, then Christianity has declined in the United States. If, however, it is not the norm, then it might appear that an intermediate position, such as we have attained by the assimilation of the British and the Continental types, may be a real advance and gain, because of the appropriation of some of the best features of both methods and the rubbing off of some of the eccentricities and excrescences of both. A decline in the relative attendance upon the public worship, and especially upon the second service on Sunday, is exactly what we would anticipate under the circumstances. It is altogether probable that the decline is much less than we had the right to expect in view of the vast influence exerted upon us by Continental types of Christianity during

the past half century. And it is altogether probable that the decline has not reached its normal goal. Especially is this the case when we take into consideration other influences which tend to diminish the attendance upon public worship.

1. In Great Britain, where the churches were established by law, the state and Church were so entwined that it was a badge of good citizenship to attend upon public worship. In antithesis with this, attendance of the nonconformists upon public worship was regarded as a standing by their principles and a test of fidelity and courage. These influences worked also in the United States during the colonial period; but during the present century this motive has lost its influence, and it is to be feared that politicians as such feel under no special obligation to attend church, especially in view of the attitude of many of the ministry as to political life and political questions.

2. In Great Britain it has been a badge of social propriety to attend public worship. Social influences still prevail greatly in the United States, in villages and small cities, and even to some extent in the churches in the great cities, where they are organized and conducted in social lines as social religious clubs. But this influence is much weaker than it used to be, and it is gradually passing away.

3. The pulpit was once the chief means of instruction and of intellectual and moral stimulation for the people. The preacher was the people's orator. The pulpit has in great measure lost its attractive power in this regard. The daily and weekly press have a greater influence in public instruction. The multiplication of cheap books also takes from the preacher a large share of his influence in this regard. Oratory in legislative bodies has 429
to a great extent lost its influence. Its place has been taken by simple, compact, time-saving statements, often printed but not delivered. Committees do the work which used to be done after discussion before the public. So the people will not listen now to the pulpit orator of former generations. They demand short, crisp sermons that bristle with points, and are practical and helpful. In other words, the oratorical and highly intellectual character of the pulpit which used to attract worshipers no longer attracts them. They feel that they can get more benefit in this regard by reading in the comfort of the home. Multitudes of people can no longer be induced to attend church to be instructed by the minister or to get his judgment on topics of the time, or to be stirred by his eloquence; they can get all these things cheaper and easier by reading at home. When, now, this is re-enforced by the fact that multitudes dislike the doctrines of the Church, and resent them when they are preached, we can easily understand that church attendance should decline very greatly from this reason.

But this is no evidence that the Christian religion has declined. If men absent themselves from public worship because it is no longer necessary for them, as good citizens and as respectable members of society, to attend, or because they may get their instruction and stimulation elsewhere easier and with less expenditure of time and money, that is simply an evidence that attendance upon church in the past has been due in great measure to other than religious reasons, and that, these no longer holding, attendance has disappeared with them. The attendance upon public worship, though reduced so far as number is concerned, is now more simply and purely for religious reasons, and therefore minister and people may with greater freedom make the services more distinctly religious.

This is indeed the real situation that has emerged. The sermon has declined relatively in importance, and rightly so. It had an exaggerated importance in the Protestant Church, especially in the non-liturgical churches. There is a world-wide tendency now, which is increasing in power, to improve and enlarge the worship of the Church. Liturgies and ceremonies of worship are more discussed now in the Protestant world than are sermons and lectures, because it is becoming every day more evident that the Church is organized for common prayer and for public worship, and not merely to furnish a pulpit for a minister. The pulpit is more and more being merged in the worship, and is losing its domination over the worship. With this tendency goes increased attention to the Holy Sacraments, especially the Holy Communion, more frequent celebrations and more frequent participation, increased opportunity of worship during Sunday and during the week, and also 430
therewith the greatly increased attention to the organization of the Church for aggressive Christian work. Those who think that the pulpit is everything in the public service naturally suppose that with the decline of the pulpit Christianity declines, but those who think that public worship is the essential thing in the Church rejoice at the changes that are taking place, and hold that Christianity is advancing. They maintain that it is not so important for the Church to gather large crowds to listen to the sermon as it is for the church doors to be ever open, with frequent services for the convenience and help of worshipers at any time, without regard to whether they are few or many, assured that thereby a much greater number of people are reached and benefited than by the former limited methods.

It is sometimes said that biblical criticism has undermined faith in Holy Scripture, and that, therefore, many absent themselves from public worship. But there is no real evidence for it. I doubt not that the opponents of biblical criticism drive many people from their congregations, just as they do when they attack the sure results of modern science, or expose their ignorance in the discussion of political and economical questions in which they have not been trained; but these people simply remove to other congregations where they will not be offended by obscurantism and intolerance. Biblical criticism really makes the Bible more attractive to the people, and its reading and exposition more interesting and influential in the Church.

A careful study of the situation makes it evident that the Christian religion is not declining in our land; but it is passing through a transition state, putting off antiquated dogmas, customs, and methods, and adapting itself to the modern world, and transferring itself so as to better accomplish its work. In no age has Christianity made more advance than in the century now drawing to a close.

The Indians of Bolivia are described by Sir Martin Conway as "an exceedingly bigoted folk, retaining under a mask of Christianity their ancient superstitions, little altered,” and are kept in order by priestly management rather than by force. Mr. Conway was seriously interfered with by them in the prosecution of his researches because the nature of his undertaking involved some outrage to their superstitions. They regard the mountains above the level of habitation as part of the other world, and holding, among other fancies, that a golden bull and a golden cross planted by supernatural agency stood on the summit of one of the peaks round the base of Mount Serata, thought that the object of the explorer’s expedition could be nothing else than to obtain possession of these priceless treasures. Hence they offered formidable opposition to him.

A CENTURY OF GEOLOGY.[A]

By Prof. JOSEPH LE CONTE.

[A] In this article I have attempted to give only the development of geological thought.

Geology is one of the youngest of the sciences. It may almost be said to have been born of the present century. It is true that knowledge concerning the structure of the earth had been accumulating ever since the time of the Greeks and Romans; it is true that these materials became more abundant and were better organized in the eighteenth century; but this knowledge had not yet taken form as a distinct branch of science until about the end of that century. There are two distinctive marks of scientific as compared with popular knowledge: First, that its fundamental idea is clearly conceived; and, second, that its method is distinctly inductive.

1. Fundamental Idea.—The fundamental idea underlying geological thought is the history of the earth. Now, until the beginning of the present century the earth was not supposed to have any history. It was supposed to have been made at once, out of hand, about six thousand years ago, and to have remained substantially unchanged ever since as the necessary theater of human history. Changes were known to have taken place and in less degree to be still taking place, but these were not supposed to follow any law such as is necessary to constitute a history, and thus to constitute a science distinct from geography. Buffon, about the middle of the last century, did indeed bring out dimly the idea of an abyss of time, preceding the advent of man, in which the earth was inhabited by animals and plants wholly different from those of the present day, but he was compelled by the priests of the Sorbonne to retract these supposed irreligious views. So tardily was the fundamental idea of geology clearly conceived that Comte, the great originator of scientific philosophy, in his classification of the sciences in 1820, denied a place to geology because, according to him, it was not a distinct science at all, but only a field for the application of all the sciences. It is evident that he did not perceive the fundamental idea underlying geology and distinguishing it from geography—viz., a life history of the earth through all time. The claim of geology to a place in a scheme of classification is exactly the same as that of astronomy. As astronomy is a field for the application of mathematics, mechanics, physics, and, recently, chemistry, but is distinguished from them all by its characteristic fundamental idea of illimitable space, so geology is a field for the application of all other lower sciences, but is distinguished from them all by her characteristic fundamental idea of 432
illimitable time. As all other sciences are terrestrial, but astronomy alone celestial, so all other sciences belong to the present—the "*now*"—but geology alone belongs to the illimitable past. The fundamental idea of the one is infinite *space*, of the other infinite, in sense of inconceivable, *time*. All other sciences, including astronomy, are but a flash-light view of Nature. Geology alone is a view of Nature in continuous movement, a life history—an evolution of Nature. This mode of thought began to dawn only in the closing years of the last and the opening years of the present century. It seems to have been first clearly conceived by the mind of Hutton in the last part of the eighteenth century.

2. Inductive Method Applied.—When the true idea underlying geology was clearly conceived and geology thus distinctly separated from other departments of science, geology may be said to have been born. But it was still in helpless infancy, its growth irregular, and even its continuous life uncertain, because a solid basis of inductive method was not yet laid. That basis was laid mainly by Hutton in 1795,[B] and still more clearly by Charles Lyell in 1830, in the principle that the study of *causes now in operation* is the only true foundation of geology.

[B] Hutton's Theory of the Earth.

Geological changes, of course, belong to the irrevocable past, and are therefore hopelessly removed from *direct* observation. Their causes and process must be reconstructed by the skillful use of the scientific imagination. Until Lyell, more or less probable hypotheses seemed all that was possible. What a field was here for the conflict of opposite extreme views! But Lyell showed that "causes now in operation" are producing similar effects under our eyes, if we will only observe. From that moment geology became a truly inductive science and its indefinite progress assured.

These two events, then—viz., the conception of geology as a distinct science, and the introduction of a true scientific method—are the greatest epochs in the history of geological science. Some dim adumbrations of these appear before this century, especially the former in the mind of Buffon, and the latter somewhat fully in the mind of Hutton, but they were not generally accepted and had not become working principles until the beginning and even some time after the beginning of the nineteenth century. These must be borne in mind in all we have further to say of the progress of geology through the century.

When the century opened, the war between the Neptunists and the Plutonists, between the Wernerites and the Huttonites, was still going on, but was approaching the usual result in such cases of dispute—viz., the 433
recognition of the fact that there was truth on both sides, and they must be combined into a more comprehensive view. The chief difference of opinion still remaining was as to the relative importance of the two agencies, aqueous and igneous. Two great advances took place about the beginning of this century: William Smith, by patient, painstaking field observation and mapping, laid the foundation of stratigraphy; and Cuvier, by his profound and brilliant studies of the wonderful discoveries of extinct mammals in the Eocene basin of Paris, laid the foundations of paleontology. These researches placed in clearer light than ever before the existence of other time-worlds before the present one. William Smith published his tabular view of the British Strata in 1790, but his map was not completed and published until 1815. Cuvier's great work on the Organic Remains of the Paris Basin was published in 1808.

Thus, early in the century the two bases of our science were laid by Smith and Cuvier. We now proceed to touch lightly only the main steps of subsequent growth through the century.

As, in the previous century and the early part of this, the discussion was between the opposite schools of Neptunists and Plutonists, with the final result of reconciliation in a more scientific view which combined these two surface views into a stereoscopic reality, so now the discussions began between catastrophism and uniformitarianism, and ended with a similar final result. Geologists, in the early part of the century, before the study of causes and processes now in operation was generally acknowledged as the only rational basis of a true scientific geology, seeing the frequent unconformities in the geological series and the apparently sudden changes of life forms associated with these unconformities, were naturally led to the conclusion that the whole history of the earth consisted of a series of sudden and violent catastrophes by which the bed of the ocean was suddenly raised and its waters precipitated on the land as a great wave of translation, carrying universal ruin and extermination of all life in its course. Such catastrophes were supposed to be followed by periods of quiet, during which the new earth was repeopled, by direct act of creation, with new forms of life adapted to the new conditions.

This view was in perfect accord with the then accepted doctrine of the supernatural origin and the permanence of species. Species were supposed to have been created at once, out of hand, without natural process, in some place (center of specific origin), spread in all directions as far as physical conditions would allow, but remained unchanged and unchangeable as long as they continued to live or until another universal exterminating catastrophe. Species are “medals of creation.” They are successive individuals struck from the 434
same die, until the die is worn out or broken. Then a new die is made, and the process of coinage of identical individuals is renewed.

Thus the whole history of the earth was supposed to consist of a succession of alternate supernatural and natural events. The catastrophes were supernatural; the times of quiet were natural. The creation of new dies or creation of first individuals was supernatural; the coinage of individuals of successive generations was natural. But on the whole the successive conditions of physical geography and the successive faunas and floras were higher and more complex according to a preordained plan. The great apostles of catastrophism were Cuvier in France and Buckland in England. According to Buckland, the last of these great catastrophes was the Quaternary or drift period, and this period was, by him and by many others since, associated with the Noachian Deluge.

Lyell opposed this view with all his power. According to him we can not judge of geological causes and processes except by study of causes and processes now in operation and producing effects under our eyes. The slow operation of similar causes and processes is sufficient—given time enough—to account for all the phenomena in geological history. Thus arose the extreme opposite doctrine of *uniformitarianism*. Things have gone on from the beginning and throughout all time much as they are going on now. This view, of course, required illimitable time, and was of great service in enforcing this idea. But, in revulsion from the previous idea of catastrophism, it undoubtedly was pushed much too far.

Meanwhile the theory of evolution was incubating in the mind of Darwin. Even Lyell, while he established the doctrine of slow uniform changes so far as inorganic Nature was concerned, was still compelled to admit supernatural catastrophic changes in organic Nature. Species, even for Lyell, were still immutable—still there were supernatural creation of first individuals, and continuance of similar individuals by natural process of generation. On the publication of Darwin’s Origin of Species by Descent with Modification, Lyell at once embraced the new view as a completion of his principle of causes now in operation and his doctrine of uniformitarianism. In a certain superficial sense evolution is certainly confirmatory of the doctrine of uniformity of causes and processes in the past and the present, but in a deeper sense it is quite contrary in its spirit. Uniformitarians of the Lyell school look upon geology as a chronicle of events—evolutionists as a life history of the earth. The one regards the slow changes as irregular, uncertain, without progress or purpose or goal; the other as an evolution to higher and higher conditions, as a gradual movement onward toward the present 435
condition and toward man as its goal. The recognition of this is only now approaching clearness. If geology is the history of the evolution of the earth from primal chaos until now, then the conditions have changed at every step, and absolute uniformity is impossible. Extreme uniformitarianism is therefore untenable. Catastrophism and uniformitarianism are opposite extremes which must be combined and reconciled. This reconciliation is only now being completed, and we therefore put off its discussion for the present. Suffice it to say now that geologic thought in this regard has passed through three stages—catastrophism, uniformitarianism, and evolutionism. And this latter is the final stage, because (1) it is a complete reconciliation between the other two, and (2) because it is plastic and indefinitely modifiable and progressive, while the other two are equally rigid and unchangeable by their mutual antagonism.

With these fundamental principles in mind, we proceed to touch briefly the most important advances during the century.

EVOLUTION OF EARTH FORMS.

The idea of the progressive development of the earth in its greater features throughout all geologic time by the action of forces resident in the earth itself preceded the acceptance of the evolution of organic forms. We have said that the fundamental idea of geology is that of the evolution of the earth through all time. Now, it was Dana who first studied geology wholly from this point of view. For him geology was the development of the earth as a unit. Before him, doubtless, geology was a kind of history—i. e., a chronicle of thrilling events—but Dana first made it a philosophic history. Before Dana, geology was an account of the succession of formations and their fossil contents. Dana made it an account of the evolution of earth forms and the concomitant and resulting evolution of organic forms. It is true that first and for a long time his evolutional conception was incomplete. It is true that while he attributed the evolution of earth forms to natural causes and processes, he still shrank from applying similar causes to the changes in life forms, but this was the almost necessary result of the then universal belief in the supernatural origin and the unchangeableness of organic forms. He lived to make his conception of evolution as a natural process, both of the earth and of organic forms, complete.

Ocean Basins and Continents.—If we divide geological causes and processes into two general kinds as to their origin—viz., internal, or earth-derived, and external, or sun-derived—evidently the former is the original 436 and fundamental kind. These determine earth forms, while the other only modify them; these determine the great features, the other only the lesser features; the former rough-hews the earth features, the latter shapes them. It is the effects of these interior earth forces which are the most important to study. And among these effects the most fundamentally important of all is the formation of those greatest features—the ocean basins and continental arches. The most probable view is that they are formed by unequal radial contraction in the secular cooling of the earth. The earth was certainly at one time an incandescently hot mass, which gradually cooled and contracted to its present temperature and size. Now, if it were perfectly homogeneous both in density and in conductivity in all parts, then, cooling and contracting equally in every part, it would retain its symmetric oblate-spheroid form, though diminishing in size. But if there were any, the least, heterogeneity either in density or especially in conductivity over large areas, then the more conductive areas, contracting more rapidly toward the center radially, would form hollows or basins, and the less conductive areas would stand out as higher arches. Thus were formed the oceanic basin and the continental arches of the lithosphere. The same causes which produced would continue to increase them, and thus the ocean basins would increase in depth and the continents in height.

The hydrosphere is still to be added. In the beginning of this process doubtless the lithosphere was hot enough to maintain all the water in the form of vapor in the atmosphere. But when the surface was cool enough the water would precipitate and partly or wholly cover the earth—whether partly or wholly would depend on the amount of precipitated water and the amount of inequality which had already taken place. The amount of water, as we know, is sufficient, if the inequalities were removed, to cover the whole surface two and a half miles deep. Inasmuch as the forming of the inequalities is progressive and still going on, it seems improbable that the inequalities had become sufficiently great, at the time of precipitation, to hold the waters. If this be so, then the primeval ocean was universal and the future continents existed only as continental banks in the universal ocean.

However this may have been, there seems little doubt that the same cause which produced the inequalities continued to operate to increase them. The ocean basins, so far as these causes are concerned, must have become deeper and deeper, and the continents larger and larger. In spite of many oscillations producing changes mostly on the margins, but sometimes extending over wide areas in the interior of the continent, this, on the whole, seems to be in accordance with the known geological history of the earth. If so, then *the oceanic* 437 *basins have always been oceanic basins, and the places of the continents have always been substantially the same*. This introduces a subject on which there has been much discussion recently—viz.:

The Permanency of Ocean Basins.—Closely associated with the Lyellian uniformitarianism was the doctrine of extreme instability of earth features, especially the forms and places of sea and land. Crust movements were irregularly oscillating to such a degree that in the course of geologic history sea and land frequently and completely changed places. Abundant evidence of this was supposed to be found in the unconformities so frequent in the stratified series. The tendency of that time was toward a belief in up-and-down movements, back-and-forth changes, without discoverable law, rather than progressive onward movement. On first thought it might seem that such lawless movement was rather in keeping with catastrophism than uniformitarianism. But not so, for the movements are supposed to be very slow. Again, it might seem on first thought that gradual progressive change—in a word, evolution—would be peculiarly in accord with uniformitarian ideas. But again not so, because this doctrine was, above all, a revulsion from the idea of supernatural purpose or design or goal contained in catastrophism. Uniformitarianism strongly inclined toward purposelessness, because of its supposed identity with naturalism. Thus for a long time, and still with many geologists, the tendency is toward a belief in irregular movements without discoverable law, toward instability of even the greatest features of the earth—viz., sea basins and continental arches. Geology for them is a chronicle, not a life history.

The contrary movement of thought may be said to have commenced with Dana. Dana studied the earth as a unit, as in some sense an organism developing by forces within itself. The history of the earth is a life history moving progressively toward its completion. The forces originating oceanic basins and continental arches still continue to deepen the former and enlarge the latter. From this point of view, oceanic basins and continental arches must have always been substantially in the same places. Oscillations there have been at all times and in all places, but they affect mainly the outlines of these great features, though sometimes affecting also the interior of continents and mid-sea bottoms, but not sufficiently to change greatly their general form, much less to interchange their places.

Such is the doctrine of permanency of oceanic basins. It is undoubtedly a true doctrine, but must not be held in the rigid form characteristic of early thought. The forces originating oceanic basins still continue to deepen 438 them and to increase the size and height of continents, but other forces are at work, some antagonizing (i. e., cutting down the continents and filling up the ocean beds), and still others determined by causes we little understand, by oscillations over wide areas, greatly modifying and often obscuring the effects of the basin-making movements. Here, then, we have two kinds of crust movements: the one fundamental and original, determining the greatest features of the earth and moving steadily onward in the same direction, ever increasing the features which it originates; the other apparently lawless, uncertain, oscillating over very wide areas, modifying and often obscuring the effects of the former. The old uniformitarians saw only the effects of the latter, because these are most conspicuous; the new evolutionists add also the former and show its more fundamental character, and thus introduce law and order into the previous chaos. The former is the one movement which runs ever *in the same direction through all geologic time*. The latter are the most common and conspicuous now and in all previous geologic time. The former underlies and conditions and unifies the history; the latter has practically determined all the details of the drama enacted here on the surface of the earth. Of the causes of the former we know something, though yet imperfectly. Of the causes of the latter we yet know absolutely nothing. We have not even begun to speculate profitably on the subject, and hence the apparent lawlessness of the phenomena. A fruitful theory of these must be left to the coming century.

Mountain Ranges.—If oceanic basins and continental domes constitute the greatest features of the earth's face, and are determined by the most fundamental movements of the crust, surely next in importance come great mountain ranges. These are the glory of our earth, the culminating points of scenic beauty and grandeur. But they are so only because they are also the culminating points, the theaters of greatest activity, of all geological forces, both igneous and aqueous—igneous in their formation, and aqueous both in the preparatory sedimentation and in the final erosive sculpturing into forms of beauty. A theory of mountain ranges therefore lies at the bases of all theoretical geology. To the pre-geologic mind mountains are the type of permanence and stability. We still speak metaphorically of the *everlasting* hills. But the first lesson taught by geology is that nothing is permanent; everything is subject to continuous change by a process of evolution. Mountains are no exception. We know them in embryo in the womb of the ocean. We know the date of their birth; we trace their 439
growth, their maturity, their decay, their death; we even find in the folded structure of the rock, as it were, the fossil bones of extinct mountains. In a word, we are able now to trace the whole life history of mountains.

Mountains, therefore, have always been a subject of deepest interest both to the popular and the scientific mind—an interest intensified by the splendors of mountain scenery and the perils of mountain exploration. The study of mountains is therefore coeval with the study of geology. As early as the beginning of the present century Constant Prevost observed that most characteristic structure of mountains—viz., their folded strata—and inferred their formation by lateral pressure. All subsequent writers have assumed lateral pressure as somehow concerned in the formation of mountains. But that the whole height of mountains is due wholly to this cause was not generally admitted or even imagined until recently. It was universally supposed that mountains were lifted by volcanic forces from beneath, that the lifted strata broke along the top of the arch, and melted matter was forced through between the parted strata, pushing them back and folding them on each side. And hence the typical form of mountain ranges is that of a granite axis along the crest and folded strata on each flank. But attention has lately been drawn to the fact that some mountains, as, for example, the Appalachian, the Uintah, etc., consist of folded strata alone, without any granite axis. In such ranges it is plain that the whole height is due not to any force acting from below, but to a lateral pressure crushing and folding the strata, and a corresponding thickening and bulging of the same along the line of crushing. Then the idea was applied to *all* mountain ranges. So soon as the prodigious amount of erosion suffered by mountains, greater often than all that is left of them, was fully appreciated, it became evident that the granite axis so characteristic of mountains was not necessarily pushed up from beneath and protruded through the parted strata, but was in many cases only a sub-mountain core of igneous matter slowly cooled into granite and exposed by subsequent erosion greatest along the crest.

Next, attention was drawn to the enormous thickness of the strata involved in the folded structure of mountains. From this it became evident that the places of mountains before they were formed were marginal sea bottoms off the coasts of continents, and receiving the whole washings of the continents. Thus the steps of the process of mountain formation were (1) accumulation of sediments on offshore sea bottoms until by *pari passu* subsidence an enormous thickness was attained. This is the *preparation*. (2) A yielding along these lines
to the increasing lateral pressure with folding and bulging of the strata along the line of yielding, until the 440
mountain emerges above the ocean and is added to the land as a coast range. This is mountain *birth*. (3) As soon as it appears above the water it is attacked by erosive agents. At first the rising by continuance of the crushing and bulging is in excess of the erosion, and the mountain grows. This is mountain *youth*. (4) Then supply and waste balance one another, and we have mountain *maturity*. (5) Then the erosive waste exceeds the growth by up-bulging, and mountain *decay* begins. (6) Finally, the erosive forces triumph and the mountain is clean swept away, leaving only the complexly folded rocks of enormous thickness to mark the place of a former mountain. This is mountain *death*. Such briefly is the life history of a mountain range.

In all this we have said nothing about causes. In this connection there are two points of especial importance: (1) Why does the yielding to lateral pressure take place along lines of thick sediments? (2) What is the cause of the lateral pressure?

1. *Cause of Yielding to Lateral Pressure along Lines of Thick Sediments.*—The earth was once very hot. It is still very hot within, and still very slowly cooling. If sediments accumulate upon a sea bottom the interior heat will tend to rise so as to keep at the same distance from the surface. If the sediments are very thick, say five to ten miles, their lower parts will be invaded by a temperature of not less than 500° to 1,000° F. This temperature, in the presence of water (the included water of the sediments), would be sufficient to produce softening or even fusion of the sediments and of the sea floor on which they rest. This would establish a line of weakness, and therefore a line of yielding, crushing, folding, bulging, and thus a mountain range. In the first formation of a range, therefore, there would necessarily be a sub-mountain mass of fused or semifused matter which by the lateral crushing might be squeezed into cracks or fissures, forming dikes. But in any case the sub-mountain mass would cool into a granite core which by erosion may be exposed along the crest. The explanation seems to be satisfactory.

2. *Cause of the Lateral Pressure.*—No question in geology has been more discussed than this, and yet none is more difficult and the solution of which is more uncertain. But the most obvious and as yet the most probable view is that it is the result of the secular contraction of the earth which has gone on throughout its whole history, and is still going on.

It is admitted by all that in an earth cooling from primal incandescence there must come a time when the
surface, having become substantially cool and receiving heat also from the sun, would no longer cool or 441
contract, but, the interior being still incandescently hot, would continue to cool and contract. The interior, therefore, cooling and contracting faster than the exterior crust, the latter following down the ever-shrinking nucleus, would be thrust upon itself by a lateral or tangential pressure which would be simply irresistible. If the earth crust were a hundred times more rigid than it is, it still must yield to the enormous pressure. It does yield along its weakest lines with crushing, folding, bulging, and the formation of mountain ranges.

This is the barest outline of the so-called "contractional theory of mountain formation." Very many objections have been brought against it, some of them answerable and completely answered, but the complete answer to others must be left to the next century. Perhaps the greatest objection of all is the apparent insufficiency of the cause to produce the enormous amount of folding found not only in existing mountains but in the folded structure of rocks where mountains no longer exist. But it will be observed that I have thus far spoken only of contraction by loss of heat. Now, not only has this cause been greatly underestimated by objectors, but, as shown by Davison and especially by Van Hise, there are many other and even greater causes of contraction. It would be out of place to follow the discussion here. The subject is very complex, and not yet completely settled.

We have given the barest outline of the history of mountain ranges and of the theory of their formation as worked out in the last third of the present century, and, I might add, chiefly by American geologists. So true is this, that by some it has been called the "American theory."

Oscillatory Movements of the Earth's Crust over Wide Areas.—We have already spoken of these as modifying the effect of the ocean-basin-making movements, and therefore now touch them very lightly. These differ from the movements producing oceanic basins on the one hand and mountain ranges on the other, by the fact that they are not continuously progressive in one direction, but *oscillatory*—now up, now down, in the same place. Again, they do not involve contraction of the whole earth, but probably are always more or less local and compensatory—i. e., rising in one place is compensated by down-sinking in some other place. Nevertheless, they often affect very wide areas—sometimes, indeed, of more than continental extent—as, for example, in the crust movements of the Quaternary period or ice age.

These are by far the most frequent and most conspicuous of all crust movements—not only now, but also in all geological times. If ocean-basin-forming movements are the underlying cause and condition of the evolution 442 of the earth, these wide oscillations, by increasing and decreasing the size and height of continents and changing greatly their contours, have determined all the details of the drama enacted on the surface, and were the determining cause of the varying rates and directions of the evolution of the organic kingdom. These were the cause of the unconformities and the corresponding apparent wholesale changes in species so common in the rocky strata, and which gave rise to the doctrine of catastrophism of the early geologists. These also have so greatly modified the contours of the continents and their size by temporary increase or decrease that they have obscured the general law of the steady development of these, and therefore their substantial permanency.

Although the most important of all crust movements in determining the whole history of the earth, and especially of the organic kingdom, we shall dwell no further on them, because no progress has yet been made in their explanation. This, too, must be left to the workers of the twentieth century.

The Principle of Isostasy.—The principle of static equilibrium as applied to earth forms was first brought forward (as so many other valuable suggestions and anticipations in many departments of science) by the wonderfully fertile mind of Sir John Herschel, and used by him in the explanation of the sinking of river deltas under the increasing weight of accumulating sediments.[C] It was afterward applied to continental masses by Archbishop Pratt[D] and by the Royal Astronomer Professor Airy.[E] But for its wide application as a principle in geology, its clear definition, and its embodiment in an appropriate name, we are indebted to Major Dutton, United States Army.[F]

[C] Philosophical Magazine, vol. ii, p. 212, 1837; Quarterly Journal of Geological Society, vol. ii, p. 548, 1837.

[D] Philosophical Magazine, vol. ix, p. 231, and vol. x, p. 240, 1855.

[E] Philosophical Trans., 1855, p. 101.

[F] Philosophical Society of Washington, 1892.

The principle may be briefly stated as follows: A globe so large as the earth, under the influence of its own gravity, must behave like a very stiffly viscous body—that is, the general form of the earth and its greatest inequalities must be in substantial static equilibrium. For example, the general form of the earth is oblate spheroid, because that is the only form of equilibrium of a rotating body. Rotation determines a distribution of gravity with latitude which brings about this form. With any other form the earth would be in a state of strain to which it must slowly yield, and finally relieve itself by becoming oblate. If the rotation stopped, the earth would accommodate itself to the new distribution of gravity and become spherical.

The same is true of the large inequalities of surface. Oceanic basins and continental arches must be in static 443 equilibrium or they could not sustain themselves. In order to be in equilibrium the sub-oceanic material must be as much more dense than the continental and sub-continental material as the ocean bottoms are lower than the continental surfaces. Such static equilibrium, by difference of density, is completely explained by the mode of formation of oceanic basins already given.

So also plateaus and great mountain ranges are at least partly sustained by gravitative equilibrium, but partly also by earth rigidity. It is only the smaller inequalities, such as ridges, peaks, valleys, etc., that are sustained by earth rigidity alone.

These conclusions are not reached by physical reasonings alone, but are also confirmed by experimental investigations. For example, a plumb line on the plains of India is deflected indeed toward the Himalayas, as it ought to be, but much less than it would be if the mountain and sub-mountain mass were not less dense and the sub-oceanic material more dense than the average.[G] Again, gravitative determinations by pendulum oscillations, undertaken by the United States along a line from the Atlantic shore to Salt Lake City, show that the largest inequalities, such as the Appalachian bulge, the Mississippi-basin hollow, and the Rocky Mountain bulge, are in gravitative equilibrium—i. e., the mountain and sub-mountain material is as much lighter as the mountain region is higher than the Mississippi-basin region.

[G] Pratt, Philosophical Magazine, vol. ix, p. 231, 1855; vol. x, p. 340, 1855; vol. xvi, p. 401, 1858.

Now, so sensitive is the earth to changes of gravity that, given time enough, it responds to increase or decrease of pressure over large areas by corresponding subsidence or elevation. Hence, all places where great accumulations of sediment are going on are sinking under the increased weight, and, contrarily, all places where excessive erosion is going on, as, for example, on high plateaus and great mountain ranges, are rising by relief of pressure.

This principle of isostasy is undoubtedly a valuable one, which must be borne in mind in all our reasonings on crust movements, although its importance has been exaggerated by some enthusiastic supporters. Its greatest importance is not as a cause *initiating* crust movements or determining the features of the earth, but rather as conditioning and modifying the results produced by other causes. The idea belongs wholly to the latter half of the present century. Commencing about 1840, it has grown in clearness and importance to the present time.

[*To be concluded.*]

THE APPLICATIONS OF EXPLOSIVES.

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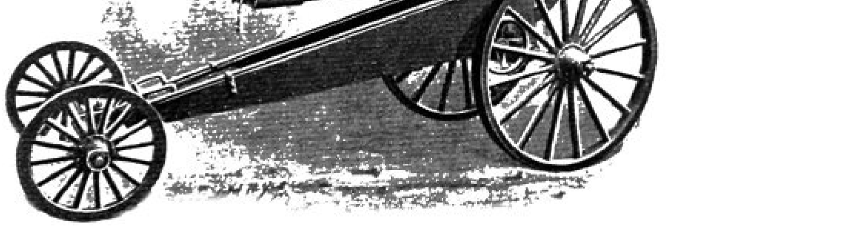
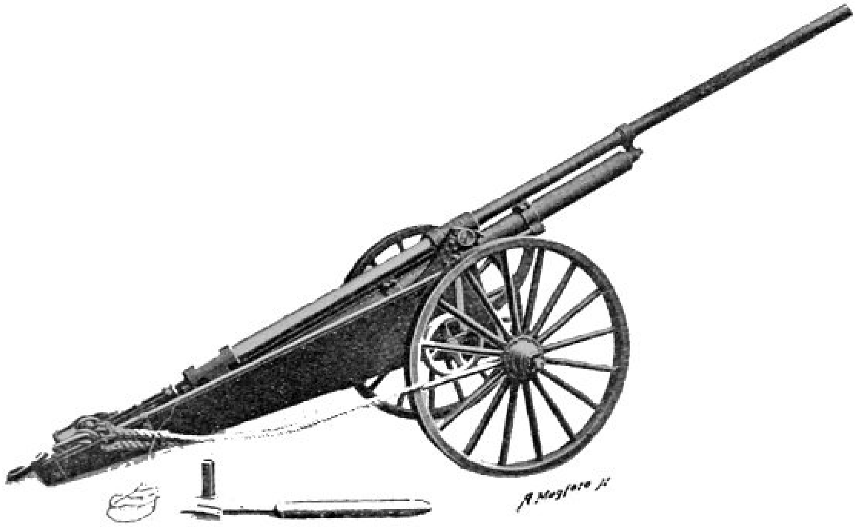
[*Concluded.*]

Gun Cotton Shell after Impact.

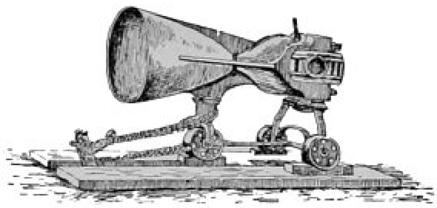
It is apparent that the range of even the most highly perfected torpedo is comparatively short, while their accuracy of travel is low. Besides, their propelling, controlling, and discharging mechanisms are complicated, delicate, and easily deranged, they are very expensive, and not only the explosive chamber but the entire system is destroyed in use. The superiority of gunpowder guns as a means of throwing projectiles to great distances with accuracy is well known, and their capacity for safely and efficiently projecting shells filled with gunpowder has long been demonstrated. It was obvious that as the superior destructive power of dynamite, gun cotton, and other high explosives became known and their commercial manufacture was assured, attempts would be made to employ them as bursting charges for shells. Experiments to demonstrate how this might be done and what effects could be expected were begun more than forty years ago, and have been continued in many different places from time to time ever since; but while it has proved that small charges might be fired with low velocities and pressures in ordinary shell, and large charges in specially constructed shell or in specially prepared forms of charge, with comparative safety so far as the premature explosion of the explosive charge itself is concerned, yet these bodies are so sensitive to the shock resulting from the discharge of the propellant, the heat generated by its combustion, and that arising from friction in the “set-back” of the shell charge and the rotation imparted by the rifling, that they can not be safely fired from modern high-power guns under service conditions, particularly as these explosives all require that the shell shall be fitted with a detonator in order that the charge may be fully exploded. The most promising results with explosives of this class have been obtained with compressed wet gun cotton, which has been packed directly in the shell in rigid blocks completely filling the shell cavity, or cut in cubes and cemented in the cavity with carnauba wax, for shell 445
filled in the former manner, but unfused, were repeatedly fired, in 1887 and 1888, at Newport, R. I., from 24-pounder Dahlgren howitzers and 20-pounder muzzle-loading rifles with service charges of powder, and though they were fired point blank into the masonry escarpment of the old fort on Rose Island, but fifty yards distant from the muzzle, so that the shells were broken up or distorted and the gun cotton in them subjected to a powerful compression, yet not only was there no premature explosion, but none of the shell exploded by impact. About the same time fused shell containing cemented gun cotton were fired in Germany, with an initial velocity of fourteen hundred feet per second, and they passed completely through four inches and three quarters of 446
compound armor, backed with twenty-four inches of oak, and burst inside the bombproof, while in 1897 fused armor-piercing shells containing wet gun cotton were fired from the six-inch quick-firing gun, with a muzzle velocity of nearly nineteen hundred feet per second, which completely perforated three inches of steel and burst behind the plate. Encouraged by these results, this system was adopted by our army officials, but, on trial in larger calibers at Sandy Hook, it gave rise to premature explosions, and the tale of disaster reached its climax on April 29, 1899, when Captain Stuart, of the Ordnance Corps, was superintending the loading of a twelve-inch torpedo shell with wet gun cotton by compressing it into the shell, for an explosion resulted which killed four men instantly and fatally wounded two others, Captain Stuart being one of them.



Sims-Dudley Pneumatic Gun, limbered up.
(Courtesy of the Scientific American.)

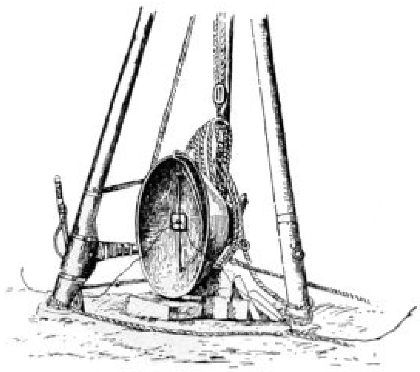


Sims-Dudley Pneumatic Gun, in Battery.
(Courtesy of the Scientific American.)



Tyndall’s Bronze Bell-mouthed Gun.

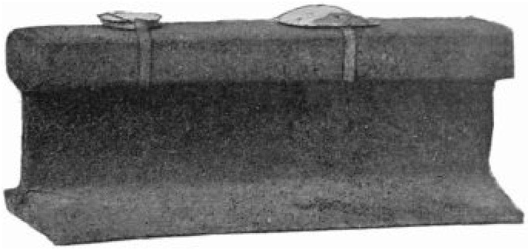
The history of the attempts made to use nitroglycerin, dynamite, explosive gelatin, and explosives of this class as bursting charges for shell fired from service guns is even less satisfactory than that given for gun cotton. It is not surprising, therefore, that inventors should have proposed catapults, slings, rotary wheels, and other means for projecting these powerful agents into the enemy’s midst, but the Mefford air gun, as mounted on the United States steamship Vesuvius, and the Sims-Dudley gun, in which a reduced charge of powder is fired in a chamber exterior to the gun proper, were deemed to possess sufficient merit to warrant their trial in the field. These devices were employed in the recent war with Spain, the pneumatic guns on the Vesuvius being used to throw shells containing three hundred pounds of gun cotton, while the Sims-Dudley guns were used on land to throw small charges of dynamite or explosive gelatin; but, beyond frightening the enemy by the startling character of their reports, these superficial charges produced no serious effect.



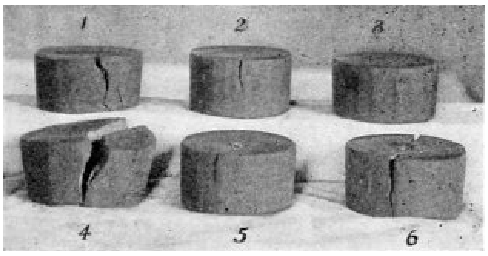
Mirror or Reflector in which to fire Gun Cotton.

There is a widespread misapprehension in regard to the devastating effect of these high explosives, for when unconfined the effect even of large charges of them upon structures is comparatively slight. At the Naval 447
Ordnance Proving Ground, so long ago as 1884, repeated charges of dynamite, varying from five pounds to one hundred pounds in weight, were detonated on the face of a vertical target consisting of eleven one-inch wrought-iron plates bolted to a twenty-inch oak backing, until 440 pounds of dynamite had been so detonated in contact with it, and yet the target remained practically uninjured; while at Braamfontein the accidental explosion of fifty-five tons of blasting gelatin, which was stored in railway vans, excavated but 30,000 tons of soft earth. This last may seem a terrible effect, but the amount of explosive involved was enormous and the material one of the most energetic that we possess, while if we compare it with the action of explosives when confined its effect becomes quite moderate. Thus at Fort Lee, on the Hudson, but two tons of dynamite placed in a chamber in the rock and tamped brought down 100,000 tons of the rock; at Lamberis, Wales, two tons and a half of gelatin dynamite similarly placed threw out 180,000 tons of rock; and at the Talcen Mawr, in Wales, seven tons of gunpowder, placed in two chambers in the rock, dislodged from 125,000 to 200,000 tons of rock.

We might cite many such examples, but on comparing these we find that the gunpowder confined in the interior at the Talcen Mawr was over forty-two times as efficient as the explosive gelatin on the surface at Braamfontein, while the dynamite at Fort Lee was over ninety times as destructive.



Railroad Torpedoes fastened on Rail.

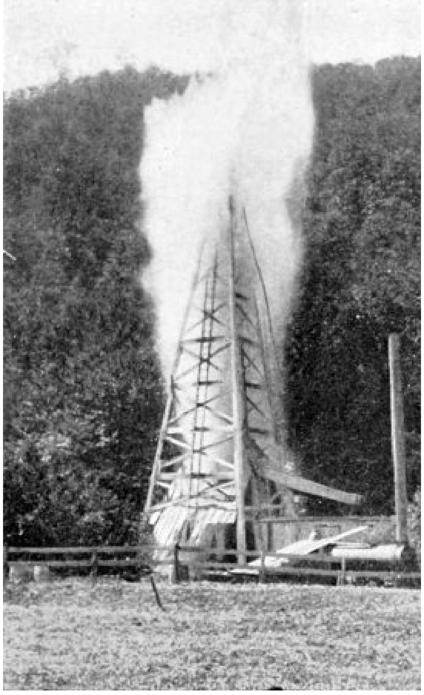


Steel Disks upon which Gun Cotton has been detonated to test their Resistance to Shock. Midvale steel disks after second fire.

Considerations similar to these led me, in 1885,[H] to point out that high explosives for use in shells must be strongly confined, and in the attack on armored ships they should be fired in projectiles that can "either penetrate the armor partially and explode in place or pierce it completely and burst inside the ship" to secure the greatest efficiency. This requires that the projectiles shall be fired at higher velocities than can be imparted to them by guns of the kind just described, and which can only be realized at present in modern breech-loading 448 rifles. Although experience has shown the futility of all our efforts to use gun cotton and nitroglycerin explosives in this manner, it has been proved that the nitro-substitution explosives can be employed with safety and effect.

[H] Van Nostrand's Engineering Magazine, vol. xxxii, pp. 1–9, 1885.

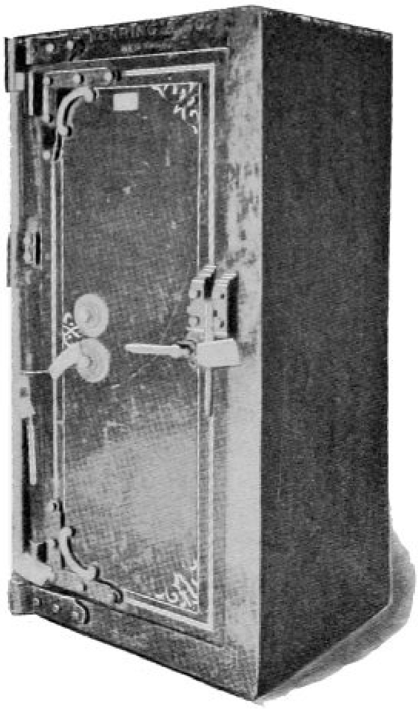
The nitro-substitution explosives are made from nitrobenzenes, nitrotoluenes, nitronaphthalenes, nitrophenols, and bodies of a similar character, and one of them, called joveite, has given excellent results in this country. After having demonstrated that the destructive effect of joveite was greater than that of gunpowder, smokeless powder, or gun cotton, and, by repeated trials under severe conditions, that service shell loaded with it could be fired from service guns under service conditions with safety, on November 3, 1897, the naval officials at Indian Head fired a fused ten-inch Carpenter armor-piercing projectile containing 8.25 pounds of joveite, with a velocity of 1,960 foot-seconds, at a Harveyized nickel-steel plate taken from the armor for the United States steamship Kentucky. The shell passed completely through the armor plate, where it was 14.5 inches in thickness, and burst immediately behind the plate. In a second round an unfused ten-inch Midvale semi-armor-piercing shell containing twenty-eight pounds of joveite was fired with a velocity of 1,925 foot-seconds at the same plate where it was sixteen inches thick. The shell penetrated to a depth of twelve inches, and the heat produced by the upsetting of the shell was so great as to explode the joveite, which broke the plate and burst the shell with tremendous violence. In fact, the explosion was so very severe that the heavy base plug of the shell was sheared longitudinally, an effect never observed before with any explosive fired at the proving ground.



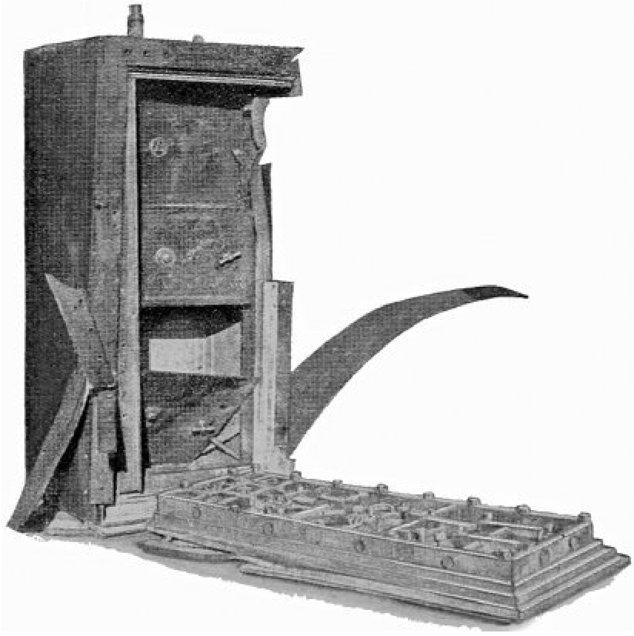
Shooting an Oil Well with Nitroglycerin.

Notwithstanding that no accident occurred in any of the many firings, that the stability and safety of the explosive are assured, and that the explosion has been effected with a well-known and long-used form of fuse, 449
no provision has yet been made to supply the service with charges for its costly armor-piercing projectiles.

Happily, the force resident in explosives may be applied to the saving as well as to the destruction of human life, advantage having long since been taken of the penetrating power of the report from the discharge of a gun to employ them as signals of distress at sea or as warnings in foggy weather. The English Lighthouse Board, under Professor Tyndall’s guidance, some years ago sought to find the form of gun best suited to this purpose, and their experiments led them at first to a bronze gun with a bell-shaped mouth. Subsequently, their attention being called to the sharpness and carrying power of the report from detonating gun cotton, an apparatus was devised in which the gun cotton was detonated in the focus of a parabolic mirror. The best results, however, were attained with rockets carrying gun cotton charges arranged to be exploded in mid air.



Safe to be opened by Detonation of Nitroglycerin. Before the charge was fired.

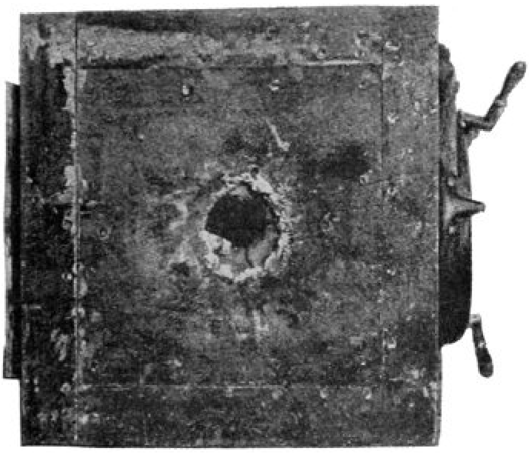


After firing Charge.

Guns have also been arranged for projecting life-lines between stranded ships and the adjacent shore, and are now employed on a smaller scale for conveying lines to the upper stories of our monumental buildings when they are on fire. By means of guns or rockets, projectiles filled with oil may be cast to considerable distances 450
from a vessel in a raging sea, so that the oil, as it diffuses, may still the waters in her course; while sounding-lines may be thrown far in advance of a vessel while she is still under way, and the soundings taken without her laying-to.

Inclosed in shallow tin boxes, which are fixed by lead strips to the top of the rail, explosives are used as torpedoes in the railroad service to give warning, by the report of their explosion as an engine runs over them, that another train is on the same track and but a short distance ahead, and by this means collisions in fogs or on curves are frequently prevented.

Explosives find applications in many industries. The farmer uses them in breaking bowlders, grubbing stumps and felling trees, in shaking the soil to fit it for deep-soil cultivation, and, in the wine-growing districts, to free it from phylloxera, while the farmer's friend has tried by this means, in times of drought, to shake the nerves of Jove and to divert the hailstorm from its course.



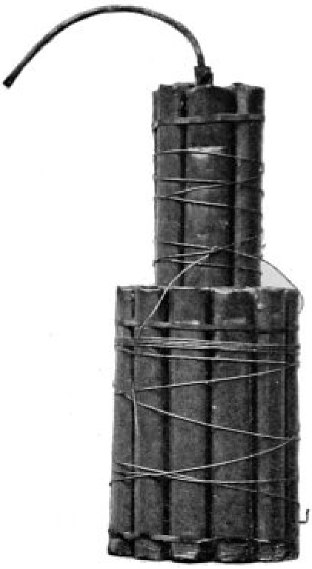
Safe perforated by Hollow Dynamite Cartridge.

The iron founder uses them in breaking up large castings. The iron smelter employs them to clear out obstructions in blast furnaces while the latter are still in operation, the dynamite, protected by a clay envelope, being inserted in the red-hot mass which clogs the furnace. The author has proposed to use the detonating explosives for testing the integrity of large masses of metals and their resistance to shock.

Dynamite has been employed in fishing, since submarine explosions of it will kill or stun fish for a long distance about the charge. This method of fishing, which threatened to deplete the waters, has very properly been prohibited by law, but guns are employed for projecting harpoons in the whale fishery, and have reduced very much the danger attending this extra-hazardous occupation.

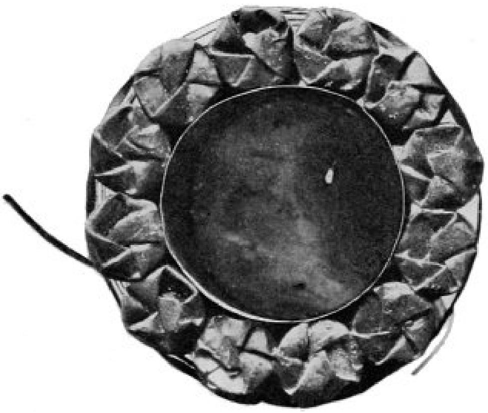
Nitroglycerin, inclosed in tin cans three to five inches in diameter and five to twenty-five feet in length, is used for shooting oil wells to free them from the solid paraffins with which they become choked, or to shake the oil-bearing sandstone so as to produce a greater yield. In this work the loaded can, having a detonating cap attached to its top, is lowered by a wire to the bottom of the well, which is often fifteen hundred feet or more in 451
depth. A perforated weight is then strung on the wire, and when the torpedo is in place the weight is allowed to fall, strike the cap, and explode the charge.

Dynamite has been used to knock out the blocking from the ways when launching ships. Fired on an iron plate placed on the top of a pile and covered with a tamping of earth or clay, it has successfully and economically replaced the pile driver. It has been found efficient in excavating holes in which to plant telegraph and telephone poles; in driving water out of quicksands in which foundations are to be laid or shafts to be driven; in slaughtering cattle; in breaking down ice dams to prevent inundations; in blowing up buildings to prevent the spread of conflagrations; in razing unsafe walls of burned buildings; in destroying wrecks which endanger navigation, and even in freeing vessels which are hard aground on shoals.



Hollow Dynamite Cartridge; Elevation.

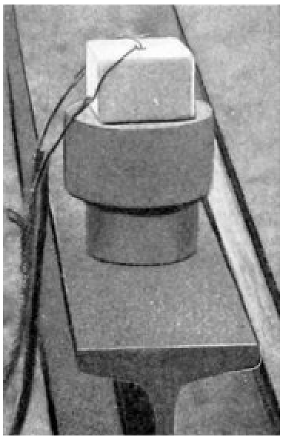
An especially notable instance was in the blasting out of the *débris* in the river at Johnstown after the frightful flood that occurred there, which formed an enormous dam above the bridge and threatened its existence, and which was successfully and expeditiously removed by blasting after all other means had been tried in vain.



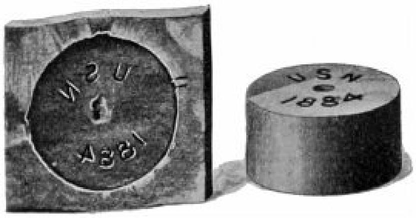
Hollow Dynamite Cartridge.
View from below.

In fact, the amount of explosives consumed in the industries is so great that the quantity employed for military purposes sinks into insignificance. Yet we have failed to refer to those industries—quarrying and mining, and the engineering operations—in which they are most extensively and commonly used, being employed so largely in mining alone that it is an almost daily occurrence for blasts containing twenty, thirty, and even fifty thousand pounds of explosives to be used in a single charge; and the system of large blasts has even become common in hard-rock excavations, such as quarries and railroad cuttings, while in the blast at the blowing up of Flood Rock, in New York Harbor, October 10, 1885, over one hundred and forty-one tons of rack-a-rock, dynamite, and mercury fulminate were used in a single shot.

Nor have I alluded to the use of explosives by the anarchists in their dastardly outrages, through which the safety of the old and young, feeble and strong, the innocent and the offending, are alike endangered; but I will touch briefly upon the applications of these powerful agents in the too-much cultivated industry of safe-robbing, since I was called upon some years ago to demonstrate, before a Government commission, how safes might be successfully attacked either in a burglarious way or by a mob with explosives, meaning by the burglarious operation that the safe should be made accessible within twenty-four hours with means such as a party of men could smuggle into a bank and which might be used without attracting attention or doing material damage to the building, and by “mob violence,” meaning that the vaults are supposed to be in the hands of a mob which has ample time and quantities of explosives at command, and does not care how much noise is made or destruction is wrought, provided the treasure is secured.



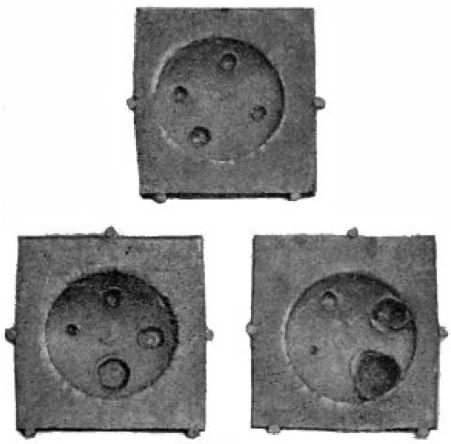
Firing on Iron Disk, resting on Lead Disk, in testing the Efficiency of Gun Cotton.



Gun Cotton Disk. With indented inscription, and iron plate upon which the indented inscription has been reproduced.

In the experiments made in a burglarious way, among others, a three-thousand-dollar square safe of the most approved construction was attacked by inserting in the crevice about the locked door four and eight tenths ounces of nitroglycerin, and in eight minutes after the operation of loading was begun the charge was fired, with the result that the whole of the jamb below the door was blown out and a hole made in the door of sufficient size to admit the hand and arm, while the doors and divisions of the interior compartments were completely shattered. On repeating the operation with four ounces and a quarter of forcite dynamite the door was completely torn off.

Among experiments made to demonstrate the resistance of structures to attack by a mob was one upon a 453
safe twenty-nine inches cube, with walls four inches and three quarters thick, made up of plates of iron and steel, which were re-enforced on each edge so as to make it highly resisting, yet when a hollow charge of dynamite nine pounds and a half in weight and untamped was detonated on it a hole three inches in diameter was blown clear through the wall, though a solid cartridge of the same weight and of the same material produced no material effect. The hollow cartridge was made by tying the sticks of dynamite around a tin can, the open mouth of the latter being placed downward, and I was led to construct such hollow cartridge for use where a penetrating effect is desired by the following observations:



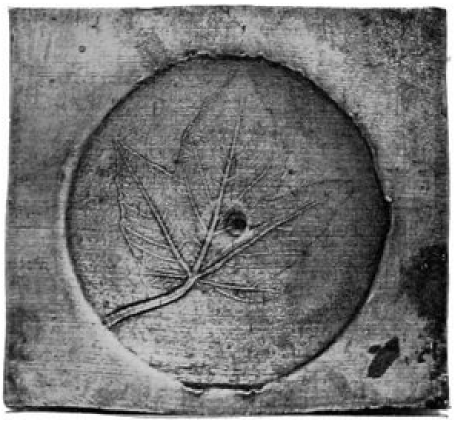
Holes produced in Iron Plates by bored Gun Cotton.

In molding the gun cotton at the torpedo station, as stated above, a vertical hole was formed in each cylinder or block in which to insert the detonator, and in the final press a steel die was laid upon the cake so that an inscription in letters and figures was forced upon it. This inscription was indented in the cylinders and was raised upon the surfaces of the blocks. When the gun cotton was fired untamped, in testing it, the cylinder or

block was usually placed with the inscribed face resting on a polished iron plate or iron disk, and after firing, if the gun cotton had detonated it was invariably found that not only was a vortex-like cavity produced below the detonator, but that the inscription on the gun cotton was reproduced on the iron plate, and, what was most singular, when the inscription was indented in the gun cotton it was indented in the iron plate, and when the inscription was raised on the surface of the gun cotton it was reproduced raised on the surface of the iron plate. In experimentally investigating this phenomenon I eventually soaked several cylinders in water, so that I could bore them without danger, and then bored holes of various diameters and depths in them, until in the last instance I bored a vertical hole an inch and three quarters in diameter completely through the cylinder. These wet cylinders were each placed on a similar iron plate, a similar dry disk was placed on each as a primer, and
they were successively fired, when it was found that the deeper and wider the hole in the gun cotton the deeper 454
and wider were the holes produced in the iron plate, until when the completely perforated gun cotton cylinder, from which at least half of the weight of explosive had been removed by the boring, was fired, the iron plate was found to be completely perforated.

Advantage was taken of this action of the rapidly moving molecules to produce some beautiful effects by interposing laces, coins, leaves from the trees, and stencils with various devices cut in them between the base of the gun cotton and the iron plate, for after the detonation of the gun cotton the objects were found to be reproduced upon the iron with the utmost fidelity and in their most delicate parts, and the impressions were raised upon the iron as the objects had been before the explosion.

In one instance a disk of gun cotton was placed in a tin which had been used in canning peas. The disk was covered with water so as to be completely immersed in it, and a second dry disk, with which to fire it, was placed upon the wet one. The face of the can resting in contact with the iron plate was originally the top of the can, through which the vegetable had been introduced, and it was consequently grooved where the cover was soldered on, and it also had an irregular drop of solder over the vent hole, the solder being raised, therefore, above the general level of the face. On firing, the can was completely volatilized or comminuted as usual, but the face of the can was reproduced in every feature and with the original values of the surface, the groove being indented in the iron, and the solder being raised above the rest of the impression.



Maple Leaf reproduced on Iron Plate.

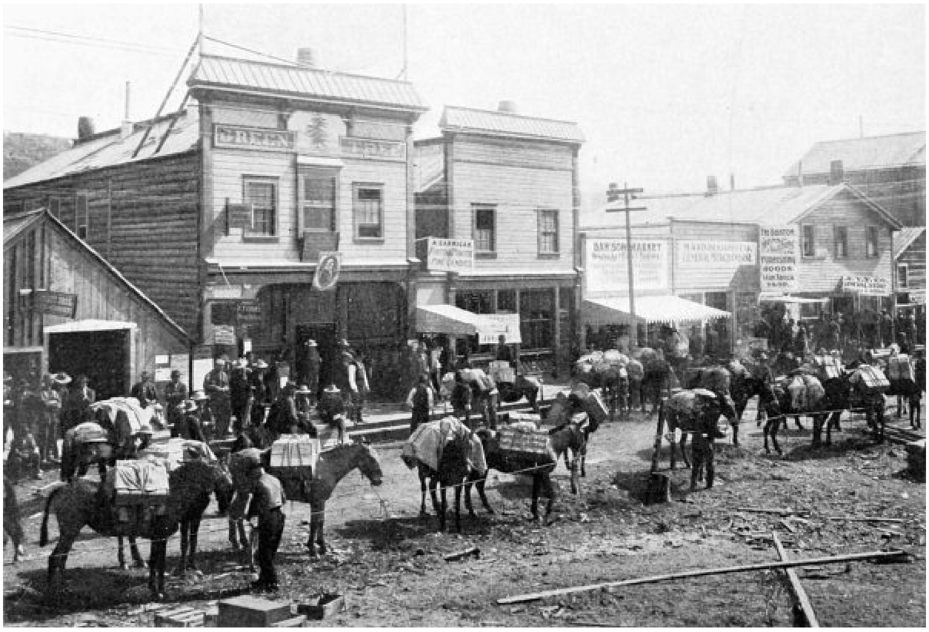
In another instance a disk of gun cotton three inches in diameter was placed in a tin can five inches in diameter, and the can, which had a smooth bottom, placed on the face of an iron I-beam. The can was filled with water so as to just cover the gun cotton, a second dry gun cotton disk was placed on the wet disk of a primer, both being in constant contact with one side of the can, and the system detonated. As a result the can and water disappeared and the face of the beam was torn off, but on recovering the pieces and matching them it was
found that not only was the smooth base of the gun cotton and the face of the can reproduced in the iron, but in 455
the space between the gun cotton and the side of the can, occupied by the water, three distinct sets of waves were produced, having an increasing amplitude from the center proceeding outward. It is evident that many curious effects can be produced with explosive substances, and I do not doubt that useful applications will be found through a close study of the phenomena attending them.

A YEAR'S PROGRESS IN THE KLONDIKE.

By Prof. ANGELO HEILPRIN.

Note.—Acknowledgment is here made to Mr. E. A. Hegg for the use of most of the photographs accompanying this article.

Two years ago the difficulties of reaching the Klondike were thought to be of such a nature as to preclude the probability or even possibility of Dawson ever becoming a place of permanent habitation. The trials of the Chilkoot and White Passes were exploited in magazine and journal from one end of the continent almost to the other, and the wrecks of humanity, and particularly of the thousands of beasts that lay scattered along the trail—the tribute to the Sahara turned to shame—were appealed to as grim testimony of the almost insuperable barrier which separated man from the object of his search. To-day, and since July 6th of the past year (1899), a steam railway traverses the full forty-two miles of the White Pass trail, and the traveler enjoys the beauties of the subarctic landscape in much the way that he enjoys the trip through the Alleghany Mountains in the East, or of the prairies in the West. Deposited at Bennett, on Lake Bennett, at virtually the head of navigation of the mighty Yukon River (otherwise known as the Lewes), he engages passage on one of several commodious steamers heading down stream or northward, and with one change—at the Miles Cañon and White Horse Rapids, where there is a five-mile portage—reaches Dawson after a voyage, delightful in its change of scene and novelty of experience, of from four to six days. It is a fact, therefore, that with a strict timing of departures the traveler from New York may make the journey to Dawson in summer time in twelve days, and exceptionally even in less; and the journey has indeed been made in eleven days and a half. Such is the change which the effort of less than two years has accomplished.



Bartlett Brothers' Pack Train, Dawson.

The Dawson of 1899 is no longer the Dawson of 1898, and much less that of the year previous. The
thousands of bateaux that were formerly lined up against the river front, in rows six deep and more, and 456
comprising all manner of craft from the small canoe to sliced sections of scows, have mostly disappeared, and in their place we now find the graceful and ungraceful forms of varying types of steamboat. It is no uncommon thing to find five or more of these larger craft tied up at one time to the river front, and the amplitude and majesty of the Mississippi boats gain but little in a comparison with some of the larger craft of the Yukon River. Overhung signs call attention to the flying queens of the river, the Bonanza King, Canadian, and Sibyl, and
thousands are offered upon the result of the race to the White Horse Rapids. So here, as in the olden days of the 457
Mississippi, the struggle for supremacy has led to the opening of the throttle and to the scraping of the fire box. Upward of a hundred arrivals from down the river were registered at Dawson during the season of open water of 1899.

Dawson has been further put into comparatively close touch with the outer world by the entry of the telegraph, and since the early days of October messages have been freely going to the seaboard at Skaguay. It is true that a cableless stretch of hundreds of miles still separates this town from the nearest port of importance on the continent, but doubtless before very long even this blank in the line of communication will have been supplied. It may be first by means of wireless telegraphy, as it is mooted that the Canadian Government looks with favor upon experimentation with the Marconi system; or, what is more likely, the desired end will be brought about by the laying of a continuous wire. The extraordinary rapidity with which the five hundred to six hundred miles of land wire were laid—five and seven miles per day—speaks well for the *morale* of the Canadian sapper and engineering service.

In its commercial and residential aspects the city has made vast progress. The days of ingulfing mires are virtually over, and from one end of the town almost to the other, one may safely tread the streets on secure board sidewalks. Not alone the main street is furnished in this way, but also several of the streets running parallel with it, and parts of streets that run across at right angles. A wise enactment, not perhaps absolutely just in its details, has swept off the shacks and booths from the river side of the front street, and one now enjoys an almost uninterrupted view of the opposing bank of the stream, already marred by giant advertising letters announcing bargain sales in merchandise, and directing to particular shops in the metropolis of the North.

Dawson's Great Fire, April 26, 1899.

The shops of Dawson have risen to the dignity of establishments having corrugated-iron covers, plate-glass fronts, and redwood shelves and counters. Following closely upon the pioneer constructions—department stores, they might be classed—of the Alaska Commercial Company are the depots of the North American Trading and Transportation Company, the Alaska Exploration Company, Ames Mercantile Company, and the Yukoner Company, several with retaining warehouses placed beyond the reach of a city fire and with dimensions that would lend dignity to locations of much larger size than the emporium of the North. Many of the smaller shops also carry a varied line of goods, but others are restricted to a specialty, and their wares are now offered at rates which are in the main only reasonably in advance of the "high" rates of the Western coast 458
towns. There are exceptions to this rule, however, especially where skilled local labor is called into requisition in a manufacture. Thus fourteen dollars for a pair of trousers made to order strikes the imagination rather forcibly, when a first-grade quality of boot or shoe can be obtained for five dollars and six dollars. Really good meals may be procured almost everywhere for from a dollar to a dollar and a half, and the best hotels supply twenty-one meals for twenty-five dollars, and these do not absolutely reject delicacies of one kind or another. 459
Cow's milk can now be had as a regular adjunct to coffee, since the milcher is no longer a stranger to the country. The price of rooms in the hotels still remains high—from four to six dollars per night, without meals—but the character of these rooms has materially improved, even though they would be considered with us decidedly third rate. In a few establishments of a more private character, lodging for a certain amount of permanency may be had for fifteen dollars the week, or, where the condition of the surroundings is not closely scanned, for even less. A new and capacious hotel, the Hotel Metropole, reared from the wealth of the "King of the Klondike"—Alexander MacDonald—has recently been added to those of less pretentious design which served the community last year. A heavy cut in rates is promised.

The conflagration of April 26th, through which perhaps one quarter of the business portion of Dawson was burned to the ground, has given opportunity for the introduction of improvements, and the most important of these is that which has resulted in the removal of houses and resorts of evil repute from the heart of the city and consigned them and their inmates to a localized area or "tenderloin" district. Women of refinement may now parade the streets without having their finer sensibilities offended through the public intrusion of the immorals of the lower world. The tone of the public places of amusement, the theaters and dance houses, has also been in a measure elevated, even if far from sufficiently so, and some real talent occasionally sparkles behind the footlights. A new "opera house," with a seating capacity of perhaps seven hundred or eight hundred, but advertised for two thousand, was thrown open to the public last August, after a construction, it is claimed, of only two weeks. Its season's *répertoire* included, among other plays, Michael Strogoff and Camille, both of which, even in their crudest type of presentation, felt well of the public pulse.

School education plays as yet little part in the morals of the Dawsonites. The greed of fortune has left scant time for the consideration of educational matters, and what little of school training is imparted to the youth of tender years comes largely in the shape of a beneficence from private hands. If the issuance of newspapers be properly classed as belonging to education, then Dawson has made material advances during the past year, for, in addition to the three weeklies which more than supplied all the information that was needed to the inhabitants of 1898, it has now a daily (the Dawson Daily News) and a Sunday paper (The Gleaner), while the pioneer Nugget has been converted into a semi-weekly. Some of these journals, which in typographical detail 460
stand fully equal to many of the foremost journals of the United States, are devoted largely to a vilification of the Yukon government, and secondarily to the nonpartisan interests of the community. But little space is given over to murders and daring deeds of robbery, since occurrences of this kind, thanks to the continued vigilance and efficiency of the Northwest Mounted Police, are all but unknown, and the safety of possessions is as well established as that of the person. The shooting of an actress by her lover, followed by the suicide of the

murderer, furnished the sensation for the year; but previous suicides, also in the ranks of the theatrical profession, had already paved a way to this form of excitement.

Two or more lines of telephone unite Dawson with the nearer mining region, and a partial city service has also been established. The city remains as yet without an electric-light plant, but it is by no means unlikely that before the present season has passed the darkness of the winter night will be lifted by the arc light, and much of the oppressiveness of the closed season thereby removed. After two winters of experience, the Dawsonites continue to think lightly of the "terrors" of the cold, and to but few apparently is the extreme of temperature a deterrent to exercise. Sleighing continues to be a pastime, with the temperature marking 40° to 50° below zero, but only with this season does it enter into the category of a fashionable recreation. Hitherto dog-sled teams performed the full service of winter travel, and divided with skating and "ski"-ing the winter exercise; but this year the snow causeways will be lively with the jingling of cutter bells and the rapid pacing of the horse.

One can not help remarking the vast improvement in the general tone of Dawson society, if by that term we may include all that constitutes the population of the city. More particularly is this marked in the case of women, among whom it is no longer a rarity to meet with strict refinement and culture. Musical *soirées* register among the events of the week, and literary recitals are not exceptional. The male portion of the population has also undergone a refining process through the departure of hundreds or even thousands of "bums," who only too late for their comfort discovered that their presence was neither a necessity to Dawson nor a mainspring to the extraction of gold from the soil. By their departure the city has probably suffered a decrease in its population of some three thousand to four thousand, but has more than received compensation in that stability of purpose which such elimination always insures. As a city of about thirteen thousand inhabitants, it enters upon its history in the year 1900 with principles cast largely upon a pure business basis, and with a future that 461
is bound in with the product of the soil.

Midnight View of Dawson, June 21, 1899.

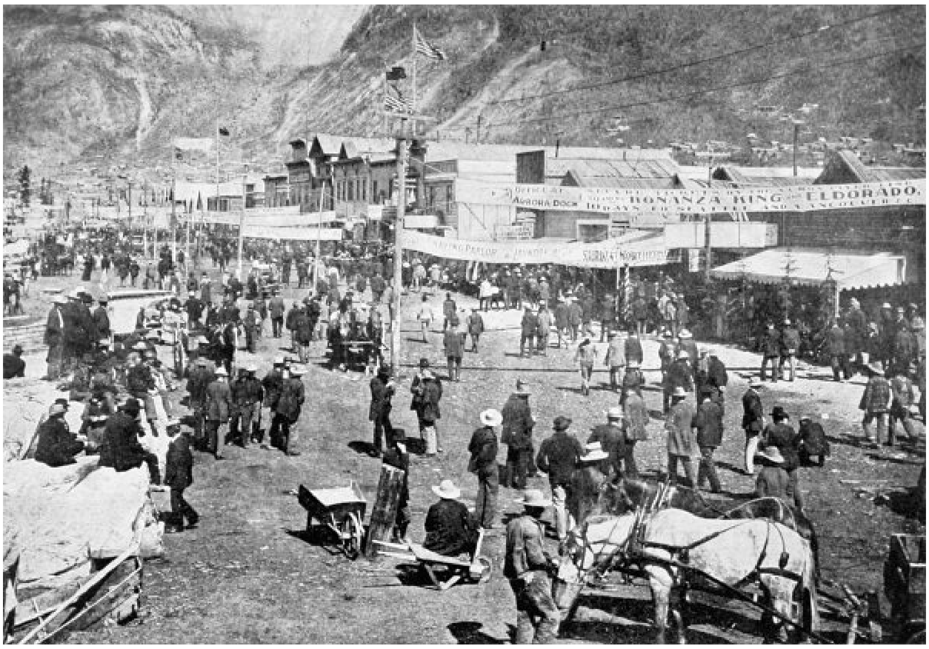
The gold resource of the Klondike region seems fully to sustain the anticipations which had been put forth touching the product of 1899. The better-known creeks, such as the Bonanza, Eldorado, and Hunker, have kept well up with their record of the previous year, and give indications of continuing as important factors in the calculation of output for some time to come in the future. The introduction of a certain amount of mining machinery, such as steam drills, thawers, and powerful pumps—applied more particularly to the deposits of the 462
benches and hillsides—coupled with a more definite method of conducting extensive operations on a comparatively economic basis, has given fresh impetus to the work of mine holders, and made largely remunerative that which had promised to be little profitable. A more just administration of the mining laws has helped to a considerate feeling among the miners, and reduced very materially the grievances which formerly fell with thick force upon the offices of the Recorder and Gold Commissioner. Access is now easily had to the records of claims, and individual "cases" receive an early and proper hearing. Electric plants have been introduced on some of the claims, so that there need be no interruption in work for the full twenty-four hours of the day.

Apart from the discovery of rich pay-dirt on creeks and gulches, such as Last Chance (tributary to Hunker), Gold Bottom (tributary to Sulphur), and American, Magnet, and Adams (tributary to the Bonanza), concerning which much skepticism was expressed last year, the filling in of assumed barren gaps in the general line of creeks has done much to inspire the feeling that more of the broad area is gold-bearing than the first surveys and explorations "indicated"—a feeling to which particular confidence has been given by the surprising wealth which has been washed out from the hillsides. For a nearly continuous four miles of the "left limit" of the Bonanza, extending northward from Gold Hill at the confluence of the Eldorado to the "forties below discovery," the crests of the hills at an elevation of some one hundred and eighty to two hundred feet above the creek are laid bare with the work of the shovel, pick, and drill, and the same or a corresponding stratigraphical height is pierced elsewhere along the stream. Gold Hill (and French Hill, on the Eldorado side), Skookum, Adams, Magnet, and American Hills, and Monte Cristo, all have their summits capped by what is now familiarly known as the “white layer”—a feature in the landscape as interesting to the casual tourist as the construction is important to the more fortunate claim holders who are located here.

Up to this time no quartz locations determined to be of positive value have been located, although a goodly number of “quartz reefs,” “lodes,” and kidney masses have been staked, restaked, and recorded. Some of these have shown gold in small quantity, but in by far the greater number of cases they have proved absolutely barren, and are without promise of yielding anything. The anticipation of many, naturally fostered by individual wish and hope, that an originating or “mother” lode must be present and found somewhere rests without any geological support so far as evidence has been accumulated up to the present time, and there is nothing that 463
looks like a promise to the geological eye. At the same time, it would be premature to assert that such a reef or series of reefs may not be discovered in the future. The hill crests that have furnished so much of the white material of the high benches of the Bonanza and the Eldorado may perhaps be searched with best advantage in this direction, and thence extended to the water parting which surrounds or incloses the upper waters of Gay Gulch.

The Columbian and the Eldorado starting from Dawson, July 4, 1899, on a Race to White Horse Rapids.

No estimate, naturally, can yet be put to the total gold supply of the Klondike region, but to inquiry that is 464
frequently put regarding the future existence of Dawson as an energetic mining camp one can unhesitatingly answer that this existence is assured for many years to come, and there are indications that point to a permanence independent of the simple supply of gold.



Street Scene, Dawson, July, 1899.

The earlier conceptions of the extreme severity of the climate of the Yukon Valley forbade the hope of agricultural possibilities, but a more intimate knowledge of the conditions prevailing in the summer time—a season of four to five months' duration, with daylight and day heat protracted far into the normal hours of night—and a comparison of these conditions with somewhat similar conditions prevailing elsewhere, have given hope not alone of a possibility, but of a probability, and there are few to-day who doubt that agriculture may not be practiced with at least a legitimate amount of success in many parts of the Yukon basin. This probability has, indeed, been already emphasized by Prof. George Dawson, and the more recent examinations of Alaskan territory, made by Colonels Ray and Abercrombie, confirm with a conviction the reference to American soil. The feeble but more than promising efforts in agriculture and gardening that were made in the region about Dawson in 1898 have borne surprising fruit in 1899, and while the results may not, for various reasons, have proved in all cases remunerative to the "prospector," they at least clearly demonstrate the possibilities to which the future may lay claim. Cabbages, turnips, peas, radishes, lettuce, and beans are now raised to perfection in favored spots along the Yukon and Klondike, and on scattered hillsides of the Bonanza and Eldorado, and a good promise is also held out for the potato. In the charming spot known as the Acklin Garden, situated on the Klondike about two miles from Dawson, oats and barley, sown on April 26th and May 22d respectively (1899), were grown to beautiful heads, and harvested in the middle of August. No wheat had ripened up to that time, and I suspect that, owing to a light frost which took place on the 19th of the same month, none of this grain came to maturity. Radishes sown on April 24th were collected on May 20th, and string beans, whose seed was scattered on May 26th, were collected on August 1st. Other successful crops were those of beets, onions, and spinach.

The exquisite beauty of the flower garden in this spot rivets the attention of all passers-by, and few there are who do not for a moment lay aside their packs to enjoy the feast of color that is presented to them. Poppies of the size and brilliance of those which adorn the fields about Naples, chrysanthemums, gorgeous dahlias, pansies, the cornflower, mignonette, and centaurea are part of the outside bloom, to which Nature "beyond the fence" has fittingly added the wild rose, anemone, fireweed, and forget-me-not. Such is the aspect of the region which to-day illumines the far North, and carries with itself a hopeful promise to many and the certainty of disappointment to many more.

THE DECLINE OF CRIMINAL JURISPRUDENCE IN AMERICA.

By GINO C. SPERANZA.

The rights of personal security, personal liberty, and private property have been called the “rights of the people of England,” and may be said to constitute the richest heirloom in the Anglo-Saxon family. While, in a certain sense, they belong to all civilized people, yet, in their practical application, they are peculiarly the creation of Anglo-Saxon common sense and love of order. The underlying principle of these rights, clothed by the Latins in the seductive garb of *Liberté*, *Egalité*, *Fraternité*, gave us a Reign of Terror, a Commune, and finally a doubtful republicanism; but the same principle, embodied in the less dazzling formula, “That no man shall be deprived of life, liberty, or property without due process of law,” produced in the hands of the Anglo-Saxons more enduring democracies “of the people, by the people, and for the people.”

With the instinct of a race born for self-government, the Anglo-Saxons have ever sought and almost always found the highest safeguard for their ancient rights in the courts of law. Between a partisan Legislature and a tyrannical Executive an honest judiciary has generally been found ready to annul the excesses of the one and to prevent any infringement by the other; so that it has become a belief, having the force of faith, that in our courts will be found the bulwark of those liberties which we consider essential to the full enjoyment of life.

Laws and courts, however, are after all the creation of men, and, like all such creations, they are necessarily imperfect and fallible; or, more correctly, they are organisms which develop and improve. In other words, justice and law are only relatively immutable and perfect. They do, indeed, represent, in a sense, abstract perfection, and at any given time they must be considered the highest criterion of human conduct. But justice and law are not such divinities that they can withdraw themselves from the operation of those forces which we call progress. Seriousness, dignity, and venerability are not sufficient to sustain the majesty of the law; it needs also adaptation to those higher conditions and broader views which mark the growth of human thought. The more we come to look upon law as the standard and gauge of upright human action, the more do we grow to expect it in consonance with the highest dictates of human knowledge and reason, for what is above us must represent what is best in us, else it will be neither respected nor obeyed. Whenever this consonance is not 467
found, human belief in the dignity of the law and in the efficacy of justice ceases. For, theoretically at least, law is so near ideal perfection that the least defect destroys it entirely; and by this “ideal perfection” is meant that *laws must reflect the highest and soundest thought of every age*. Laws that fail in this cease to be a power for good; they are then looked upon either as ridiculous or as oppressive. If the former, they defeat their ends by becoming dead laws; if the latter, they become a source of disorder and discontent. Hence we see that jurisprudence is essentially evolutionary and progressive, and that the majesty of the law does not lie in its age but in its perennial youth, or, more correctly, in its successive rejuvenescence. It is true that in China the antiquity of a law is its highest prestige, but, as a consequence, Chinese justice is proverbially inefficient and barbarous. It therefore follows that the constant study and improvement of what we have called the safeguards of our fundamental rights should be our highest duty, and the object of the care and solicitude of the State. It is not enough to rest contentedly in the thought that a Magna Charta, a Petition of Rights, and sundry written constitutions protect us. Their very existence is but an argument for our eternal vigilance. Now, the question to be here examined is whether we have exercised that care and vigilance which are essential to the free enjoyment of our rights.

Let me premise the statement that the protection of the rights of life, liberty, and property is peculiarly within the province of the criminal law. What constitutes the right of life, liberty, and property can not be defined or described, except negatively by a definition of what will be deemed its infringements. These we call crimes. To declare what acts come within the definition of such crimes is the function of the criminal courts.

It is upon the criminal law, therefore, that we must rely for the enunciation of what acts shall constitute a breach of the right of life, liberty, and property, and it is to the criminal bench and bar that we must turn for the correct interpretation and application of such enunciations. Hence the more time and attention we devote to the study of criminal legislation and to the enlightenment of the criminal bench and bar, the more will the safety of our rights be increased and strengthened. Likewise, the more we allow criminal legislation to be the product of hasty consideration and the criminal bar to drift into disrepute, the more the safety of our rights will be proportionally weakened.

The first question that presents itself is, “*What is done by our law schools for the study of criminal law?*” The answer is not very encouraging. Let us take those law schools which are of most importance, either by reason of 468
their curriculum or of their attendance. Harvard, with a three years’ course, devotes two hours a week for one year to criminal law (including criminal procedure). Allowing nine months of four weeks each to the scholastic year, and a weekly average of eighteen hours, it will be found that the time devoted to the study of criminal law (including procedure) is a little over *three per cent* of the entire course. By a similar computation we find that Columbia devotes to criminal law (and procedure) a little over *four per cent* of the entire course, which is about the percentage given by Yale and a little lower than that of the Universities of Michigan, Cornell, and New York respectively.

These computations are based upon figures given in the catalogues of those universities, or kindly furnished by the deans. Nothing more eloquent of the decline of the study of criminal jurisprudence in our country could be cited. But the catalogues of these law schools add further proof. At none of them is there a professor whose instruction is confined solely to criminal law. Nearly all the instructors in criminal law devote but a small part of their time (and probably of their study) to the teaching of this subject. In Columbia the instructor in criminal law is professor of international law and diplomacy;[I] at Harvard the incumbent of the chair of criminal law teaches the law of carriers; that of Michigan teaches the law of bills and notes and of public corporations; that of the New York University the law of sales and wills. It is, moreover, a significant fact that the faculties of the above-named institutions, while recommending to law students the optional study of political economy, constitutional history, taxation, physical science, English literature, and modern languages as conducive to a

higher standard of legal culture, utterly fail to advise them to pursue courses in criminal anthropology, criminology, or penology. In other words, it is deemed advisable that the future lawyer should bring to the aid of his civil practice the complementary knowledge of French and history, for instance, but it is of no importance that he should be acquainted with the results of modern criminologic and penologic research. Thus the conclusion is forced upon us that the study of criminal law, whose importance I have endeavored to set forth,
has become a subject at sufferance in our universities, a practically optional course of little consequence to the 469
student, and of no interest to the teacher.

[I] This has since been changed; but the change makes the case worse, as the new instructor in criminal law teaches not only two branches of the law (as under last year's course), but five—viz., Criminal Law, Wills and Administration, Common-Law Practice and Pleading Bankruptcy, and Bailments and Carriers.

From the very beginning of his legal career the future lawyer is made to feel that the field of criminal law is not the one in which to exercise his best talents. Both the school curriculum and popular sentiment strengthen this prejudice. To the community at large our criminal courts have come to mean places where criminals are sentenced or rogues saved on technicalities; they have ceased to be centers of justice, where innocent men are saved and guilty men tried according to the law of the land. Hence has arisen the popular belief (despite the rule that the accused shall be considered innocent until his guilt is proved), shared in a measure by the bench and bar, that every man accused of crime is criminal and depraved, and that, therefore, contact with him should be avoided. Thus the criminal lawyer, who necessarily must come in touch with such alleged crime and depravity, is practically ostracized not only from the community but also from the civil forum.

The existence of such prejudice against the criminal bar is most deplorable. Men of ability and position will shun criminal practice, leaving the field clear to unscrupulous shysters. Let it be remembered that to a man charged with the commission of a crime and deprived of his liberty the lawyer appears a savior; that the accused is practically at his lawyer's mercy, being under most trying duress and very easily influenced. The temptation for unprofessional dealing is here at its highest, because of the manifest advantage of the lawyer who is able, or whom the client believes to be able, to unlock the prison doors. It takes men of more than ordinary fiber to persistently resist such temptation in all its forms. Hence the necessity of upright and learned men at the criminal bar. But how few are our great criminal practitioners! How often have I heard lawyers, too young and clientless to allow themselves preferences, declare most decidedly that they were willing to do anything "except criminal law"! They had been trained to look upon it not merely as inferior but as degrading practice. Yet it is common knowledge that in European countries, where less boast is made of inalienable rights, it is the ambition of all lawyers to get a reputation at the criminal bar. It is there, in fact, that reputations are made.

It is likewise in those countries where many would make us believe that life, liberty, and property are not as sacredly guarded as in our own country, that the criminal laws are a constant object of scholarly study and
investigation. The great progress made in the study of crime, the building up of a criminal science and a 470
criminal sociology, is almost exclusively the work of Continental criminologists. Penology has indeed engaged our attention, but criminology has been almost practically ignored by us.

Of criminal law it was long ago said that, "by reason of the numberless unforeseen events which the compass of a day may bring forth," the knowledge of its provisions "is a matter of universal concern." Yet, despite this "universal concern," our criminal law has been and still is inferior to our civil law. I have pointed out at the beginning of this article how the majesty of the law depended essentially upon its ever-recurring rejuvenescence; that law was a living organism, subject to change and the forces of evolution.

The theories on criminal responsibility and on crime in general, in the light of modern medical, anthropologic, and sociologic sciences, have completely supplanted the old doctrines, yet criminal legislation has apparently taken no notice of them. Modern science tells us that our antiquated tests of criminal responsibility result in sending hundreds of men to prison who ought to be sent to asylums, but we do nothing to avoid this scandal. Under our system the courts are obliged to let the conclusions of the learned judges who occupied the bench three hundred years ago have more weight than the positive investigations of the men of science of our day, and so, consciously or unconsciously, numberless crimes are committed in the name of *stare decisis*. True it is that in some jurisdictions, and notably in New York, the courts have recognized to some extent the progress of science and its influence upon juridic theories. But even in these cases the concession has been made only in *civil* cases. Thus Mr. Bishop, in his Criminal Law, is obliged to point out that our courts recognize *two kinds of insanity*—to wit, *civil and criminal irresponsibility*. Why the test to be applied in the case of the validity of a will should be different from that applied in the case of murder does not seem very clear. The scientific test as to insanity has been oftentimes recognized and applied by our civil tribunals, but the criminal judges still cling with unabashed attachment to the unscientific and unprogressive rule in McNaughten's case. The Guiteau trial, which followed that celebrated decision, added fresh authority to the English view, and practically made the rule to be applied in criminal trials a legal dogma.

In an able and exhaustive paper by Mr. J. H. Dougherty on this very subject, before the Society of Medical Jurisprudence, the evils of such dogmatism in criminal law are strikingly set forth. "Life," he said, "should be as
sacred as property. While society needs protection from the criminal, it does not require that the protection 471
should be insured through the application of a fallacious and discredited legal dogma."

This is but one example of the unprogressiveness of our criminal jurisprudence. Yet, if we really have the ancient principle of the right of life and liberty at heart we ought to recognize that this legal dogma is a greater menace to the practical abrogation of the right than the despotism of an unscrupulous executive. For while the latter is an infringement of a right which the law forbids, the former is a breach of a right which the law sanctions. Again, the theories regarding the object of penal provisions have entirely changed. Punishment has been scientifically shown to be practically useless either as a deterrent or as a correctional remedy. Yet our penal codes are confessedly based on the idea of punishment and retribution. We have indeed made some little headway, such as indeterminate sentences and suspension of judgment, but only in a scattered and tentative way.

The additions to or changes in our criminal codes have been unimportant and unprogressive. What additions are made are slipshod in their make-up, at times partisan in intent, seldom in harmony with the teachings of modern science, and oftentimes in disregard of fundamental principles. Our legislators grant “hearings” before passing a law affecting the business of a few privileged men and give it due weight; but criminal bills, which may affect the public, are generally “rushed through,” probably because of an absolute lack of interest. This is but a repetition of Blackstone’s complaint against criminal legislation in his day. “It is never usual in the House of Commons,” he wrote, “even to read a bill which may affect the property of an individual without first referring it to some of the learned judges and hearing their report thereon. And surely equal precaution is necessary when laws are to be established which may affect the property, liberty, and perhaps the lives of thousands.” And he thus concludes his observations: “The enacting of penalties to which a whole nation should be subject ought not to be left as a matter of indifference to the passions or interests of a few, who upon temporary motives may prefer or support such a bill.”

The lack of public interest and of intelligent consideration by the people and the bar in criminal problems and criminal legislation are clearly shown by the paucity of criminal statistical data furnished by various States.

Penological research is based on an intelligent study of statistics, and civilized nations, recognizing this fact, have provided elaborate systems of records based on the suggestions of statistical science. But with us statistical facilities in the field of crime are not merely primitive or old-fashioned, but in many cases shamefully 472
absent. In reply to requests addressed to the Secretaries of State of various States for official statistics of crimes committed in their respective jurisdictions, the answers I received were in a number of cases negative. The officials mentioned replied that no statistics were published by the State in Illinois, Georgia, New Jersey, Tennessee, Kentucky, Maryland, Vermont, California, Idaho, Missouri, South Carolina, Connecticut, Texas, Wisconsin, Nebraska, Mississippi, Virginia, Colorado, and Kansas. It is true that in some of these States this lacuna is filled in by special prison reports or reports of commissioners or of the attorneys-general. But even in these cases, as well as in those published officially by the State (Ohio, Indiana, New York, Massachusetts, and Louisiana), the information furnished is a monument of antiquated methods and of very little value to the student of criminology. How, then, can we study the grave questions of crime and criminals without a basis of computation?

It may be true, as some claim, that Continental jurists have refined the criminal law to an unpractical degree and too much on classic and theoretic lines, but it will not be claimed that by adhering to an old-fashioned and obsolete criminal jurisprudence the Anglo-Saxons are safeguarding their fundamental liberties. That there is something essentially wrong, or at least antiquated, with our criminal law is evidenced by the popular discontent against it, which is too widespread and insistent to be the result of ignorance or sentiment. If there is inertia as to changes in the law it is probably because, while feeling that there is something wrong, the people either can not define it or the conservatism of centuries in this field is unconsciously affecting their better intentions. Who will deny (and I address this question to lawyers and judges) that, under our system, guilty men escape and innocent men suffer in larger numbers than it should be, even allowing for the defects inherent in all human systems?—that technicalities and not facts often save scoundrels; that unscrupulous lawyers do not avoid them, and the best of judges are obliged by legal dogmas to respect them? Who will deny (and I address this question to sociologists and penologists) that the penal provisions of our present laws are inappropriate, inelastic, and unscientific; that they neither prevent nor reform; and that the basic principle of our penal codes is still retribution and punishment? Can it be that the right of life, liberty, and property is becoming a pious fraud? Of course, it is not claimed that we have less liberty now than our fathers had three centuries ago; progress never stops, and each day is something gained; but it seems clear that the juridic basis and form of our 473
liberties have not kept up with the progress of those very liberties. Yet, what we call rights must have a counterpart or reflection in our laws. We may, while enjoying those rights, forget that the juridic basis on which they stand is crumbling with age. Unless that basis is rejuvenated the entire edifice must eventually fall. While we are in full possession of our rights we need no laws to guarantee them; but it is when those laws are encroached upon that there arises the necessity of juridic sanction for them.

The right of life, liberty, and property constitutes the essence of the “law of the land.” But the conception of rights, as we have seen, changes and progresses. The law of the land must likewise change and progress.

Laws may be the highest and best creation of man’s intellect, but they are not “hedged in by any divinity.” That is why they are neither infallible nor unchangeable. Yet, as the highest and best creation of man’s intellect, and as the final criterion of human public conduct, they should conform to the best thought and to the highest scientific progress. If they do not approach this standard they are worse than useless, for they become legalized means of oppression. It is then that Justice needs a bandage over her eyes, not to avoid partiality, but to hide her shame.

THE BLIND FISHES OF NORTH AMERICA.

BY CARL H. EIGENMANN,

PROFESSOR OF ZOÖLOGY, INDIANA UNIVERSITY.

"An investigation into the history of degenerate forms often teaches us more of the causes of change in organic Nature than can be learned by the study of the progressive ones."—WEISMANN.

The caves of the United States are inhabited by three cave salamanders, two of them with degenerate eyes; by six cave fishes, all with impaired vision—five of them with rudimentary eyes, one with eyes the most degenerate among vertebrates; and by several mammals. It is thus seen that among the interesting features of the North American fauna the blind vertebrates are not the least. Yet during the past twenty-five years the only additions to our knowledge, aside from diagnoses of new species, have been a few random notes on the habits and a short account of the eye of Troglichthys by Kohl.

Various classes of vertebrates have blind members, but no large vertebrate has become blind or permanently taken up its home in caves. Blatchley reports that a number of cats have established themselves in 474
Wyandotte Cave, where they bring forth and rear their young. They have exterminated the cave rats, and now station themselves in a narrow passage of the cave and capture bats as they fly through.

Among the permanent residents in dark places we have, among mammals, the moles, which habitually live in burrows of their own make. In Mammoth Cave lives a rat—Neotoma pennsylvanica. In Marengo Cave, Indiana, white-footed mice have established themselves. Although with unimpaired eyes, they have acquired ears and whiskers longer than the rest of their kind living outside.

In Florida occurs a blind lizard—Rhineura floridana. It burrows in the ground, and is colorless and blind.

FIG. 1.—The cave salamander of the Mississippi Valley (*Spelerpes maculicauda*).

Of salamanders, one blind species lives in European caves. In the large caves of the eastern United States no blind salamanders have been found, although other species, especially Spelerpes maculicauda, abound. In the caves of Missouri a veiled-eyed salamander, Typhlotriton, has been described within recent years by Stejneger. Still another salamander, Typhlomolge, having rudimentary eyes, has been cast up from an artesian well at San Marcos, Texas, and occurs in the cave streams about that place.

The most abundant of the blind vertebrates, both in individuals and in species, are the blind fishes. These, from their geographical distribution, may be separated into three groups: (1) Those inhabiting the depths of the ocean; (2) those inhabiting dark places along the shores of the ocean; (3) those inhabiting the underground fresh waters.

The fishes, blind or partially blind, living in the depths of the ocean bordering the American continents, are as follows: 1. Ipnops Murrayi Günther lives at depths varying from 955 fathoms to 2,158 and has the very wide distribution suggested by the localities from which specimens have been secured—viz., off the coast of Brazil, near Tristan da Cumba, near Celebes, latitude 24° 36′ north, longitude 84° 51′ west, and off Bequia. This is the only vertebrate in which no vestige of an eye has been found. Ipnops stands alone in a family. 2. The Brotulidæ have several members blind or with very much reduced eyes in various parts of the globe. Aphyonus mollis G. 475
and B., 955 fathoms, and Alexeterion parfaiti Vaillant, 5,005 metres, are the only ones found in the neighborhood of America. 3. The Lophiidæ are represented by Mancalias Schufeldtii Gill, from a depth of 372 fathoms. Other blind species are found in foreign waters, while others with small eyes are found in American waters. The majority of deep-sea fishes have well-developed eyes.

The shore fishes have their blind representative in Typhlogobius californiensis St., which lives under rocks between tide water on the coast of southern and Lower California. I have elsewhere described the habits of this form. In the fresh-water caves of Cuba two blind fishes—Stygicola denta Poey and Lucifuga subterraneus Poey—

have been found. Their relatives live in the ocean, Brotula barbata in Cuban waters; some of the others are blind and inhabitants of deep water.

The inland fresh-water fishes are represented by Gronias nigrilabris Cope, a catfish from cave streams of eastern Pennsylvania, and by members of the Amblyopsidæ, concerning which a more detailed account is given below.

The Amblyopsidæ.—The Amblyopsidæ are a small family of fishes allied to the Cyprinodontidæ. They are found in the Mississippi drainage basin and in certain southeastern streams. Three of the members of the family, the Chologasters, are provided with well-developed eyes, while four other species are cave fishes in the strictest sense, being blind and colorless. The distribution of the different members of the Amblyopsidæ is as follows:

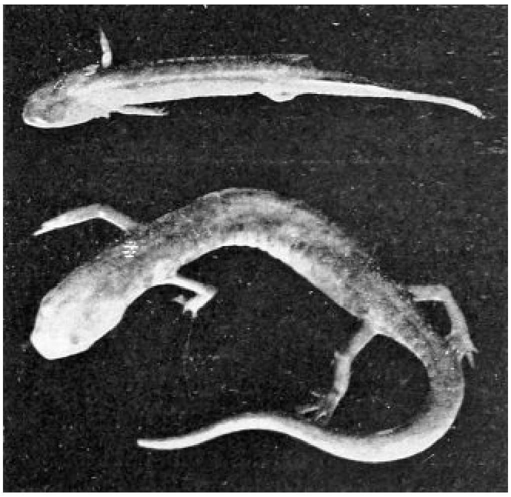


Fig. 2.—The larva and adult of the Missouri cave salamander (*Typhlotriton*).

Chologaster cornutus is found in lowland swamps of the Southern States from the Dismal Swamp to the Okefinokee Swamp. Chologaster Agassizii is found in subterranean streams in Tennessee and Kentucky. Chologaster papilliferus has so far been found only in southwestern Illinois.

Amblyopsis is abundant in the cave streams of the Ohio Valley south of the east fork of White River.

Typhlichthys subterraneus inhabits the region south of the Ohio and east of the Mississippi. A single 476
specimen of another Typhlichthys has been found north of the Ohio River in a well at Corydon, Indiana. Troglichthys rosæ inhabits the caves west of the Mississippi in Arkansas and Missouri.

Chologaster.—Mr. E. B. Forbes secured a school of Chologaster papilliferus for me, and he wrote: “The little fishes were found under stones at the edges of the spring very close to the bluff, and when disturbed they swam back under the cliff.... None were found at any considerable distance from the face of the cliff.” I found the Chologaster Agassizii to act similarly in the river Styx, in Mammoth Cave. As soon as my net touched the water they darted in under the ledge of rock at the side of the little pool in which I found them.

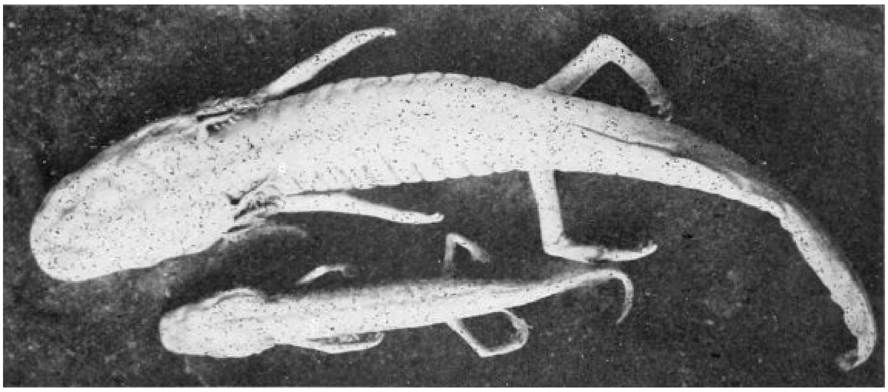


Fig. 3.—Blind salamander from an artesian well at San Marcos, Texas (*Typhlomolge*).

Chologaster papilliferus detects its food entirely by the sense of touch. Two which were kept in an aquarium for over a year were starved for a few days. They became very nervous, continually swimming along the sides of the aquarium. Asellus was introduced. These, even if quite near, produced no effect if moving in front of the Chologaster. The moment one came in close proximity to the fish from any direction, by a flashlike motion it was seized. None of them were swallowed. The fish became very alert after the introduction of the sowbugs, and when swimming forward would strike at a part of a leaf if it came in contact with the head of the fish. It seemed evident that the eye gave no information of the character of the object. As Asellus was not altogether to their taste, Gammarus was introduced. One of these swimming rapidly toward the chin of the Chologaster from behind and below was instantly seized when it came in contact with the fish. The eye could not have located the

Gammarus at all. The action is in very strong contrast to the action of a sunfish, which detects its food by the sight. It is undoubtedly this peculiar method of locating and securing food which has enabled the Amblyopsidæ 477
to establish themselves in caves.

The Chologaster in general make-up is like Amblyopsis, but is somewhat longer-jointed. It sits with its pectorals extended. When it moves horizontally for some distance the pectorals are usually pressed to the sides, the propelling being done largely by the tail very much after the manner of a salamander, which it resembles. In swimming toward the surface it uses its pectoral fins chiefly, and the fish usually sinks to the bottom as soon as its efforts to raise itself are stopped.

Individuals kept in aquaria with one end darkened either collected in the darkened area floating about, or under leaves or sticks in any part of the aquarium. They are frequently found under a floating board, where they float with the tops of their heads in contact with the board, their bodies slanting downward. They seek the dark, regardless of the direction of the rays of light. These characteristics they have, in great part, in common with the blind members of the family. The adult Amblyopsis frequently floats with its head to the top of the water, the tail sloping downward, and in swimming along ledges of rock the top of the head is applied to the ledge. I have captured many specimens simply by scraping my net along the surface of a ledge.

Typhlichthys, living in total darkness, has retained the habit of staying under floating boards, sticks, and stones. Miss Hoppin noticed that Troglichthys swims with its back to the sides of the aquarium, and I have repeatedly noted the same in the young of Amblyopsis up to fifty millimetres, and the still younger Amblyopsis frequently hides under rocks.

Amblyopsis.—The general impression given by Amblyopsis is that of a skinned catfish swimming on its back. The expressions, “They are catfish”; “They look as though they were skinned”; “They are swimming on their backs,” are heard from those who see these fishes for the first time.

The largest individual secured by me measured 135 millimetres in total length. Individuals as large as this are rare. The usual length of an adult is about 90 millimetres. One individual was mentioned to me at Mammoth Cave having a length of 200 millimetres!

Amblyopsis is found in pools in the cave streams it inhabits. I have secured as many as twelve from a pool perhaps ten by fifty feet in size. Very rarely they are to be found in the riffles connecting the pools. I have seen them lying at the bottom, or swimming, or rather gliding, through the water like “white aquatic ghosts.” In the
aquarium they lie at the bottom or at various depths in the water, their axes making various angles with the 478
horizontal, their pectorals folded to their sides. When swimming slowly it is chiefly by the use of the pectorals. The strokes of the pectoral are lazily given, and the fish glides on after a stroke till its impetus is exhausted, when another stroke is delivered. The fishes frequently roll slightly from side to side at the exhaustion of the result of a stroke. When swimming rapidly the pectorals are folded to the sides, and their locomotion is then similar to that of a salamander—by the motion of the tail. They readily adjust themselves to different depths, and are usually perfect philosophers, quiet, dignified, unconcerned, and imperturbed, entirely different from such eyed species as minnows and sunfishes which are sometimes found in caves and which are much more readily disturbed by any motion in the water, making it almost impossible to capture them when found in the caves. The pectorals are also almost exclusively used when quietly rising in the water. At such times the pectorals are extended laterally and then pressed to the sides, beginning with the upper rays. A downward stroke is delivered in this way not quickly, but with apparent lazy deliberation. In swimming the pectorals are brought forward upper edge foremost. The center of gravity seems to be so placed in regard to their various axes that the fish does not lose its balance whatever its position. They float horizontally in the water without any apparent effort to maintain their position, or with the main axis inclined upward, with the snout sometimes touching the surface of the water, apparently lifeless. Once one was seen resting on its tail in a nearly vertical position, and one while quietly swimming was once seen to leisurely turn a somersault and swim on undisturbed. At another time the same individual rolled completely over. When one of them is kept out of the water for a short time it frequently goes in a corkscrew-shaped path through the water, continually spinning around its long axis. In their quiet, floating position it is difficult to determine whether they are alive or not.

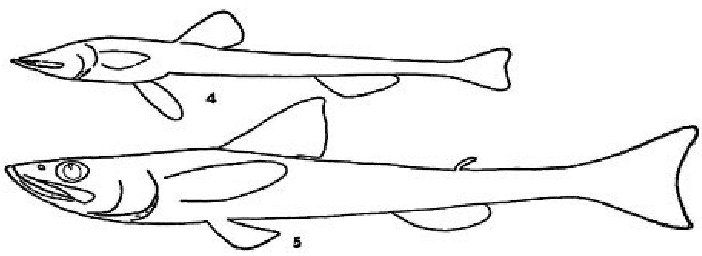


Fig. 4.—*Ipnops Murrayi*, living at a depth of 1,500 to 2,100 fathoms.

Fig. 5.—*Chlorophthalmus gracilis*, from 1,100 fathoms, off New Zealand.

I have not found the slightest difficulty in capturing Amblyopsis with a small dip net, either from a boat or 479
while wading through the subterranean stream, and I have caught one in the hollow of my hand. At such a time all the noise I could make did not affect the fishes found swimming in the water. Frequently they were taken in the dip net without apparently noting the vibrations produced in the water until they were lifted out of it; very rarely a fish became evidently scared. Such a one would dart off a few feet or a few inches, and remain on the *qui vive*. If not pursued, it soon swam off quietly; if pursued, it not infrequently escaped by rapidly darting this

way and that; when jumping out of the water, often an abrupt turn in the opposite direction from which it started would land it in the net, showing that their sense of direction was not very acute. At other times, if disturbed by the waves produced by wading, one or another individual would follow a ledge of rock to the bottom of the stream, where it would hide in a crevice. But very frequently, much more frequently than not, no attention was paid either to the commotion produced by the wading or by the boat and dip net. In general, it may be said that the fishes in their natural habitat are oblivious to disturbances of the water until frightened by some very unusual jar or motion, probably a touch with the net, when they become intensely alert. The fact that they are not easily frightened suggests the absence of many enemies, while their frantic behavior if once scared gives evidence either that occasional enemies are present and that they are very dangerous, or that the transmission of the instinct of fear is as tenacious as the transmission of physical characters.

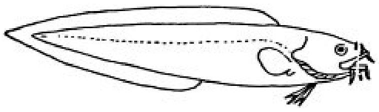


Fig. 6.—*Brodula barbata* from Havana, Cuba.

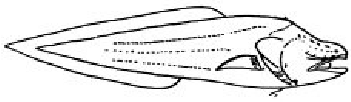


Fig. 7.—*Stygicola dentatus* from the caves of Cuba.

Contrary to Sloan’s observation, that they detect the presence of a solid substance in their path, I have never noticed that those in confinement became aware of the proximity of the walls of the aquarium when swimming toward it. Instead, they constantly use the padded, projecting lower jaw as bumpers. Even an extremely rapid dart through the water seems to be stopped without serious inconvenience by the projecting jaw.

The first observations on the feeding habit of Amblyopsis are those of Cope. He remarks that “the projecting lower jaw and upward direction of the mouth render it easy for the fish to feed at the surface of the water, where it must obtain much of its food.... This structure also probably explains the facts of its being the sole 480
representative of the fishes in subterranean waters. No doubt many other forms were carried into the caverns since the waters first found their way there, but most of them were like those of our present rivers—deep-water or bottom feeders. Such fishes would starve in a cave river, where much of the food is carried to them on the surface of the stream.”

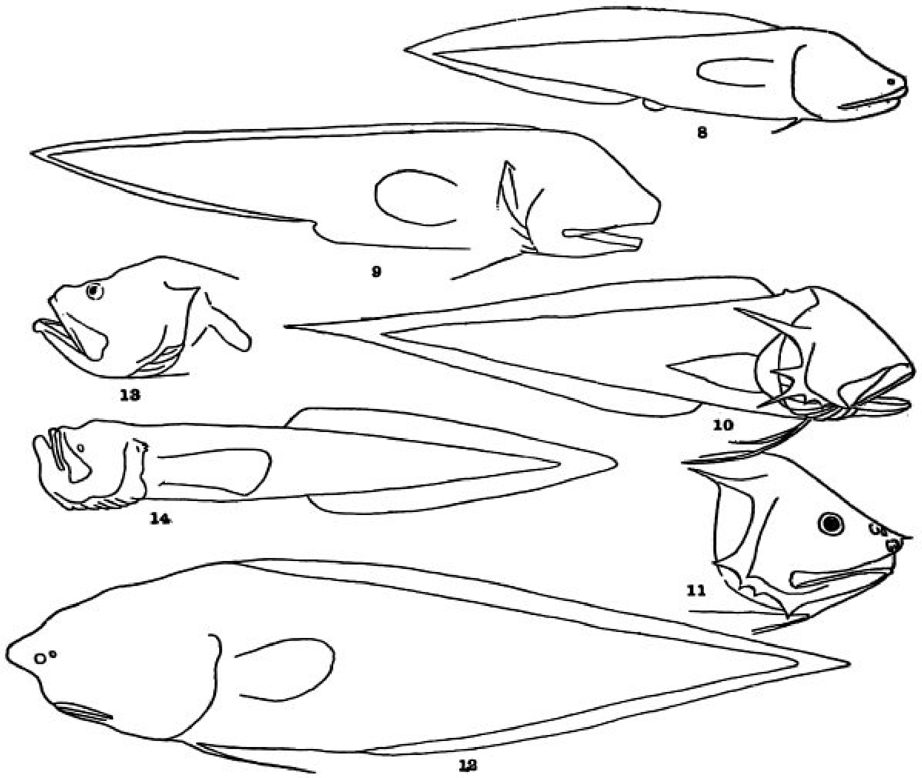


Fig. 8.—*Aphyonus gelatinosus*, 1,400 fathoms, between Australia and New Guinea.

Fig. 9.—*Aphyonus mollis*, 955 fathoms, 24° 36′ north, 84° 5′ west.

Fig. 10.—*Tauredophidium hextii*, 1,310 fathoms, Bay of Bengal.

Fig. 11.—*Acanthonus armatus*, 1,050 fathoms, mid Pacific, off the Philippines.

Fig. 12.—*Typhlonus nasus*, 2,150 to 2,440 fathoms, north of Australia and north of Celebes.

Fig. 13.—*Hephthacara simum*, 902 fathoms, Coromandel coast.

Fig. 14.—*Alexeterion parfaiti*, 5,005 metres, North Atlantic.

The observations of Cope are entirely erroneous, as we shall see, and the speculations based on them naturally fall to the ground.

Dr. Sloan recorded one Amblyopsis which he kept twenty months without food. “Some of them would strike eagerly at any small body thrown in the water near them, rarely missed it, and in a very short time ejected it from their mouths with considerable force. I tried to feed them often with bits of meat and fish-worms, but they retained nothing. On one occasion I missed a small one, and found his tail projecting from the mouth of a larger 481
one.”

Wyman found a small-eyed fish in the stomach of an Amblyopsis.

Hoppin was struck by the fact that, if not capable of long fasts, Troglichthys must live on very small organisms that the unaided eye can not discern. Garman found, in the stomachs of Troglichthys collected by Hoppin in Missouri, species of Asellus, Cambarus, Ceuthophilus, and Crangonyx.

All the specimens of Amblyopsis so far taken by me contained very large fatty bodies in their abdominal cavity, a condition suggesting abundance of food. The stomachs always contained the *débris* of crustaceans, a closer identification of which was not attempted. One young Amblyopsis disappeared on the way home from the caves, and had evidently been swallowed by one of the larger ones. A few old ones, kept in an aquarium from May to July, were seen voiding excrement toward the last of their captivity, and their actions at various times suggested that they were scraping the minute organisms from the side of the aquarium. The young Amblyopsis reared in the aquarium seemed to feed on the minute forms found in the mud at the bottom of its aquarium. Some Cœcidotæa placed in the aquarium of the young soon disappeared, and the capture of one of these was noted under a reading glass. The fish was quietly swimming along the side of its aquarium; when it came within about an inch of the crustacean it became alert, and with the next move of the Cœcidotæa it was captured with a very quick, well-aimed dart on the part of the young fish. Others were captured while crawling along the floor of the aquarium. From all things noted, it seems very probable that Amblyopsis is a bottom feeder, and that it also picks food from the walls of the caves. It is not at all improbable or impossible that food should be captured at the surface or in open water, but there seems no warrant for Cope’s supposition that Amblyopsis is a top feeder. I have frequently seen larger specimens, which had been in captivity for several weeks, nosing about the bottom of the aquarium, with their bodies inclined upward in the water and quietly taking in the organic fragments at the bottom. An Asellus stirring about at such a time always produced an unusual alertness.

The number of respiratory movements of Amblyopsis averaged nineteen a minute in five observations,

reaching a maximum of thirty in a small individual and a minimum of fourteen in a large one. This is in strong contrast to Chologaster, the number of whose respiratory motions reached an average of eighty per minute in five observations, with a minimum of fifty-six and a maximum of one hundred and eight in a small specimen. Dr. 482
Loeb has called my attention to the more rapid absorption of oxygen in the light than in the dark; this extended would probably mean the more rapid absorption of oxygen through the skin of light-colored animals, a matter of doubtful value, however, to species living in the dark.

The gill filaments are small as compared with the gill cavity.

Oxygenation probably takes place through the skin. Ritter[J] has suggested the same for Typhlogobius.

[J] Ritter, Museum of Comparative Zoölogy, vol. xxiv, p. 92.

"Cutaneous respiration is not unique in Typhlogobius and the Amblyopsidæ. In the viviparous fishes of California the general surface, and especially the fins, which have become enormously enlarged, serve as respiratory organs during the middle and later periods of gestation; the fins are a mass of blood-vessels, with merely sufficient cellular substance to knit them together. There is, however, no pink coloration."

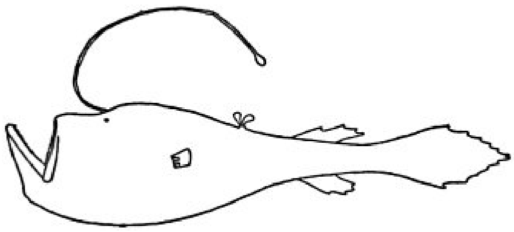


Fig. 15.—*Mancalias Schufeldtii*, 372 fathoms.

Skin respiration would account for the extreme resistance to asphyxiation in Amblyopsis and Typhlogobius. About forty-five examples of Amblyopsis were carried in a pail of water four hundred miles by rail, with only a partial change of water three times during twenty-four hours. A smaller number may be kept for days or weeks—probably indefinitely—in a pail of water without change. The characteristics of Typhlogobius along this line have been set forth elsewhere.

Sticks, straws, etc., are never avoided by the fishes even when perfectly imperturbed. By this I mean that they are never seen to avoid such an object when it is in their path. They swim against it and then turn. An object falling through the water does not disturb them, even if it falls on them. A pencil gently moved about in front of them does not disturb the fishes much, but if the pencil is held firmly in the hand it is always perceived, and the fish comes to a dead halt ten or fifteen millimetres before it reaches such an object. On the other hand, they may be touched on the back or tail before they start away. They glide by each other leisurely and dignified, and if they collide, as they sometimes do, they usually show no more emotion than when they run against a stick. But this indifference is not always displayed, as we shall see under the head of breeding habits.

A number kept in an aquarium with a median partition, in which there was a small opening, were readily 483
able to perceive the opening, swimming directly for it when opposite it. This observation is in direct contrast to their inability to perceive solid substances in their path. A sharp tap on the sides of an aquarium in which six blind fishes were swimming, where they had been for a number of days undisturbed, in a dark room, caused nearly all of them to dart rapidly forward. A second tap produced a less unanimous reaction. This repeated on successive days always brought responses from some of the inmates of the aquarium. Those responding were not necessarily the nearest to the center of disturbance, but sometimes at the opposite side of the aquarium or variously distributed through it. After a few days the fishes took no notice of the tapping by any action observable in the artificially lighted room.

Such tapping on a well-lighted aquarium containing both Chologaster and Amblyopsis was always perceived by the Amblyopsis, but the only response from these imperturbable philosophers was a slight motion of the pectorals, a motion that suggested that their balance had been disturbed and that the motion was a rebalancing. Chologaster, on the other hand, invariably darted about in a frantic manner. One individual of Amblyopsis floating on the water was repeatedly pushed down by the finger without being disturbed. If, however, they are touched on the side they always rapidly dart away.

From everything observed, it is quite evident that Amblyopsis is not keener in perceiving objects or vibrations than other fishes, and ordinarily pays much less attention to them. Whether it possesses a greater power of discrimination of vibrations it would be difficult to say. It certainly possesses very elaborate tactile organs about the head. These tactile organs are probably more serviceable in detecting and precisely locating prey in the immediate neighborhood than for anything else. Some observations on young Amblyopsis are of interest in this connection.

The young, with a large amount of yolk still attached, show a well-developed sense of direction. A needle thrust into the water near their heads and in front of them causes a quick reaction, the young fishes turning and swimming in the opposite direction. They will do this two or three times, then, becoming exhausted, will remain at rest. Sometimes an individual will not move until it is actually touched by the needle. The needle must come within about three or four millimetres of the fish before it is noticed. Then, if it produces any result, it causes the fish to quickly turn and swim some distance, when it falls to the bottom again and remains at rest. If the 484
needle is placed behind the fish, it will swim directly forward; if at the side or about the middle, it causes the fish to swim directly forward or to turn and swim in a direction opposite the origin of the disturbance. Younger specimens have, as yet, no power over the direction of their progress; the wiggling of the tail simply produces a

gyration, with the yolk as pivot.

A young blind fish, six months old, swims about in a jerky manner, chiefly by the use of its pectoral fins. It keeps close to the side of the vessel, usually with its back to the glass. (The aquarium was a cylindrical jar three hundred millimetres in diameter and three hundred millimetres high.) It perceives a stick thrust toward it as readily as a seeing fish can. It always perceives from whatever direction it may be approached, and will invariably dart away a short distance, sometimes making sharp turns to avoid the stick, and always successfully. It can be approached from the top nearer than from the sides or from in front. It does not avoid the sides of the aquarium, which it frequently strikes. It is a bottom feeder; its intestinal canal is always partially full.

A long series of experiments was made on Amblyopsis and Chologaster to determine their reaction to white and monochromatic light. Without going into the details of these experiments, it may be stated that Amblyopsis avoids the light, regardless of the direction or the color of the rays. The same is true of Chologaster, except that they were positively attracted by the red rays of the spectrum as against the blue.

We owe the first observations on the breeding habits of Amblyopsis to Thompson, who states that a fish “was put in water as soon as captured, where it gave birth to nearly twenty young, which swam about for some time, but soon died; ... they were each four lines in length.” Little or nothing has been added to our knowledge of this subject since that time, but the highly interesting supposition of Thompson that they were viviparous has gained currency, and it is therefore unfortunate that in this respect he was in error.

Putnam adds to the above that, judging from some data in his possession, the young are born in September and October, and further along remarks that they are “undoubtedly” viviparous.

The eggs are laid by the female in under her gill membrane. Here they remain for perhaps two months, till the yolk is nearly all absorbed. If a female with young in her gill pouches is handled, some of the young are sure to escape. This was observed, and gave rise to the idea that this fish is viviparous. Eggs have been obtained as early as March 11th and as late as September, and the indications are that the breeding season extends throughout the year. The eggs are large—2.3 millimetres in diameter from membrane to membrane—and about 485 sixty to seventy are laid at one time.

Certain structures gain an entirely new significance in the light of the breeding habits. These are the enlarged gill cavities, with the small gills, the closely applied branchiostegal membrane, and the position of the anus and sexual orifices. The latter are placed just behind the gill membrane in such close proximity to it that they can be covered by it. It is probable, therefore, that the membrane is drawn over the sexual orifice and the eggs deposited directly into the gill cavity. In an individual thirty-five millimetres long the anus is situated between the origin of the pectorals; in one twenty-five millimetres long it lies between the pectorals and ventrals. In the young it lies behind the ventrals, as in other fishes.

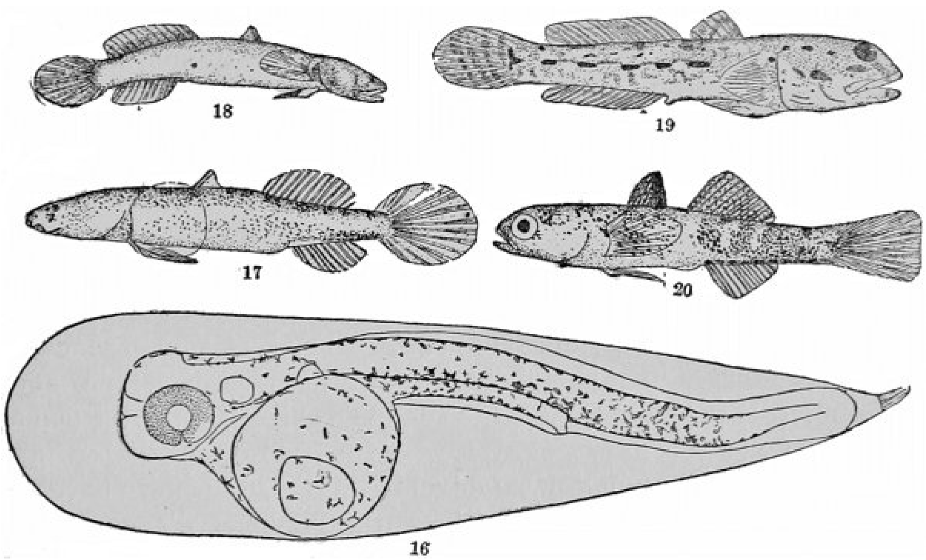


Fig. 16.—The embryo of *Typhlogobius*, showing the well-developed eye.

Fig. 17.—A young *Typhlogobius*, times 4-2/9.

Fig. 18.—Adult *Typhlogobius*.

Fig. 19.—Adult *Gillichthys-y-cauda* living in crab holes in San Diego Bay.

Fig. 20.—Young *Gillichthys mirabilis* under the same magnification as Fig. 17.

In an aquarium containing six Amblyopsis two took a great antipathy to each other. Whenever they touched, a vigorous contest began. Frequently they came to have a position with broadside to broadside, their heads pointing in opposite directions. At such a time the fight consists in quick lateral thrusts toward the antagonist to seize him with the mouth. The motion is instantly parried by a similar move by the antagonist. This blind punching may be kept up for a few seconds, when, by their vigorous motions, they lose each other and jerk themselves through the water from side to side, apparently hunting for each other. At this time they are very 486 agile, and move with precision. When the belligerents meet one above the other, the snapping and punching is of a different order. While jerking through the water immediately after a round, if one of the belligerents touches one of the neutrals in the aquarium it frequently gives it a punch, but does not follow it up, and the unoffending fellow makes haste to get out of the road, the smaller ones doing so most quickly. If, after an interval of a few seconds, a belligerent meets a neutral they quietly pass each other without paying any further attention, whereas if the two belligerents meet again there is an immediate response. Whether they recognize each other by touch or by their mutual excitability I do not know. At one time, in another aquarium, I saw one belligerent capture the other by the pectorals. After holding on for a short time it let go, and all differences were forgotten. The thrust is delivered by a single vigorous flip of the tail and caudal to one side. These fights were frequently noticed, and always occurred between males.

The absence of secondary sexual differences in the cave fishes is a forcible argument in favor of sexual selection as the factor producing high coloration in the males. The absence of secondary sexual differences in cave animals opposes the idea of Geddes and Thompson that the differences are the external expression of maleness and femaleness.

Attempts at acclimating Amblyopsis in outside waters have so far failed.[K] A few were placed in Turkey Lake, Indiana. They were surrounded by a fine wire net, to keep off other fishes. They died in a few days, as the result of attacks of leeches, *saprolegnia*, or fish mold, and from unknown causes. Others were kept in an elongated box sunk into the ground, where fresh spring water flowed through it constantly. *Saprolegnia* sooner or later destroyed all of them. They live longest in quiet aquaria, where the water is rarely changed. The young I have secured died, with one exception, within a few weeks. The difficulty of rearing the young is not at all insurmountable. They eat readily. Their aquaria must be kept free from green plants, and have a layer of fine mud, with a few decaying leaves, in the bottom. They will feed on minute crustaceans and other micro-organisms. When they have reached a sufficient size, examples of Asellus are greedily devoured. Fish mold is the bane of the larvæ. Many of them were found with tufts of the *hyphæ* growing out of their mouths and gill openings.

[K] Since the above was written an apparently successful attempt has been made to colonize them in a pool at Winona Lake. A record of this colony will be published later.

THE MAN OF SCIENCE IN PRACTICAL AFFAIRS.

By F. W. CLARKE.

The human mind is addicted to the creation of types, a process which implies classification and generalization of a somewhat low order. Some prominent feature of the thing classified is selected for emphasis, and there is often a degree of exaggeration which leads, in the end, to caricature. John Bull, Brother Jonathan, the Jew of the comic papers, and the stage Irishman are examples of this tendency. So, too, a profession or occupation is summed up in one conventional character, with a little truth distorted as if seen reflected from the surface of a curved mirror. The likeness is there, but unlike the reality. The individual embodiment of the type is rarely, if ever, encountered.

The man of science deals with questions which commonly lie outside of the range of ordinary experience, which often have no immediately discernible relation to the affairs of everyday life, and which concentrate the mind upon apparent abstractions to an extraordinary degree. Accordingly, the scholar, the scientific investigator, is typified as an elderly dreamer in spectacles, who is so uncouth, so self-forgetful, so absent-minded, and so ignorant of practical matters as to be hardly more than a child. He is one to be cared for and humored, like an imbecile—treated with some consideration, perhaps, on account of his learning, but never to be trusted in the transaction of business nor in the administration of public affairs. With him, as an antithesis, is contrasted the practical man, who knows whither his steps are tending, who has learned to control others, and who never dreams of abstractions during office hours, if indeed he troubles himself about them at all. The one is thought to be vague, visionary, and unpractical; the other is deemed efficient, precise, prompt, and clear. Has this distinction any basis in reality? Do scientific pursuits disqualify a man for administrative responsibility?

These questions, like all other legitimate questions, are to be answered by evidence, and the popular impression is entitled to no weight whatever. This evidence is to be found by a study of the thing itself, the man of science as he actually is; by an examination of the training which he receives, the character of the work which he does, and the results which he accomplishes. By this method it will be found that the supposed type is purely imaginary, that the workers in science exhibit all the variations which are found in any other group of occupations, that the human race as a whole is their only symbol or representative. The man of science may be 488
grave or gay, moral or immoral, social or unsocial, keen or visionary—in short, he may exemplify any trait of human nature, except the traits of ignorance and stupidity. He must be intelligent and educated, methodical and exact; apart from these qualifications he may resemble any other man, chosen from any other vocation. Indeed, his nearest analogue is the so-called man of business, and the chief distinction between the two is that one deals with unfamiliar, the other with familiar things.

The direct tendency of the scientific training is to develop as fully as possible the positive traits which have been mentioned. Each science is a body of systematic, well-organized knowledge, with clear fundamental principles and distinct outlines. The study of science is a continual discouragement of obscurity or vagueness; it is a discipline in the statement and solution of definite problems, and it trains one to see things as they are, apart from all irrelevancies. The technicalities of science, so bewildering to the layman, are merely aids to exactness, avoidances of circumlocution—in short, they are practical devices whereby labor is saved. Economy of effort is one of the features in which the scientific training excels.

The results of such a training vary, of course, with the individual, and depend upon his personal peculiarities. A broad man is broadened by it; a narrow man shuts himself up within the limits of a specialty. To some extent specialization is necessary, but there is a wide difference between the man who sees only his own province and one who realizes its relations to other fields. The same distinction is found in commercial life, and with the same results. The specialist in money, in stocks, in iron, or in cotton may be just as narrow as the specialist in stars, or reactions, or insects, and know little or nothing of any subject outside his own. Neither narrowness nor breadth of view is monopolized by any vocation. The mere fact that men of science rarely devote their attention to accumulating wealth does not prove them to be unpractical. They are not, as a rule, careless or thriftless in money matters; they are as likely to handle their financial affairs intelligently as any one else, but their main business lies in other directions. If seldom a millionaire, the man of science is still more seldom a bankrupt. In wild speculation the so-called practical man takes the lead, and anything which bears the trade mark of electricity, from the electrical refining of sugar to the extraction of gold from sea water, can secure from otherwise shrewd financiers the support which a worker in science would contemptuously refuse to give. A few years ago the would-be rain-makers obtained the money for their experiments from men of business, and from Congress even, in spite of advice based upon scientific knowledge, and failure was the inevitable end. 489
In that borderland between business and research, which is known as applied science, the scientific student is more practical than the financier. When both work together, wealth is produced, but the seedtime of abstract investigation always precedes the harvest. The commercial value of exact knowledge is often very great, but to the prospective investor this truth is not always evident.

The practical value of the scientific training is perhaps most fully recognized in Germany. There the importance of the investigator, the apparently abstract scholar, is thoroughly understood, and to his work the great industrial advance of Germany is largely attributable. In chemical and electrical industries this is particularly true, and their growth can be directly traced to the influence of the universities. The German professor is a man trained to research, and from among his students many of the best investigators are chosen for service in the factories. German competition in the commercial world is to-day the bugbear of other European countries, and its success is due, first of all, to the utilization of trained intelligences. In our own country the importance of applied science is fully realized and its achievements are beyond dispute, but the scholar as yet receives less consideration than the commercial expert. The latter is practical, the former is regarded as visionary. Accurate knowledge is a good thing, but rule-of-thumb experience is often thought to be better. It is only when knowledge and experience join hands that the highest practical results are attainable, the one factor tending to advance, the other to perpetuate, industry. The man of affairs is not a practical man until he appreciates the force of these propositions.

At bottom the scientific training is a training in clear thought, precise statement, accurate observation, the verification of evidence, and the ascertainment of truth. Why should its recipient be unfitted for practical things? Good administration, the effective transaction of business, implies system, exactness, the judgment of evidence upon its merits, and the prompt solution of problems as they arise, and to each of these requisites the scientific education is directly related. What other training is less likely to produce dreamers, or more likely to develop efficient men? The main distinction between the workers in science and men of other vocations is one of aim, a difference in ambition, perhaps a difference in the point of view. The scientific scholar seeks to discover and possibly to apply new truth; and after that his ambition is to win the recognition of his fellows, to gain reputation, rather than to acquire wealth. He may not be indifferent to the latter purpose, but it is not his chief end. It is difficult to do both things well.

For the administration of large interests, involving the control of men and the building-up of great 490
institutions, men of science have over and over again demonstrated their fitness. In the scientific societies of the world they have shown their capacity for organization, and in the management of schools and colleges their ability has often been proved. Among the presidents of universities and technical schools who have been drawn from the ranks of science I may mention Eliot, of Harvard; Gilman, of the Johns Hopkins; Drown, of Lehigh; Jordan, of the Leland Stanford; Chamberlin, of Wisconsin; Morton, of the Stevens Institute; and Mendenhall, of the Worcester Polytechnic. The Institute of Technology in Boston has been directed successively by Rogers, Runkle, Walker, and Crafts; the Columbia School of Mines was built up by a group of scientific workers, aided by President Barnard; and the list might be lengthened almost indefinitely. Have these men fallen below the average of their fellows? Have they not shown at least as high administrative ability as has been found elsewhere? The mere statement of their names is a sufficient answer, and renders argument unnecessary. With them the scientific training has not been a disqualification, nor even a handicap; it has rather been to their advantage, for to it they owe much of the insight, the power to grasp great problems intelligently, the ability to interpret evidence, and the tendency to prompt and decisive action, without which successful administration is impossible.

Again, consider the scientific institutions of the world, the museums and observatories, and the various governmental organizations in which science is recognized. In our own country, the Smithsonian Institution and National Museum were built up by Henry and Baird, in spite of great and varied difficulties; the Coast Survey was created by Hassler and Bache; and the Geological Survey was developed by a group of men among whom Hayden, King, and Powell were pioneers. The last-named organization has been controlled from the beginning by men of science, and the Coast Survey has been weak only when under nonscientific management. The Commission of Fish and Fisheries owes its existence and a great part of its effectiveness to its creator, Baird; the Army Medical Museum and Library represents the executive genius of Billings; and in none of these institutions has partisan politics ever exerted an appreciable influence. No bureaus of the Government have been more wisely or more efficiently handled than those which men of science have controlled; in none have there been fewer errors or scandals; there is not one in which the essential purpose of its existence has been better fulfilled.

Instead, then, of excluding the scholar, the investigator, the man who knows, the man of scientific training, 491
from his fair share of public responsibility, we should do well to call him into service more and more. He may be, he often is, averse to administrative work, for the reason that it interferes with his chosen occupation, and hinders the prosecution of research. But his training and his mental bias are both needed in public affairs, wherein the scientific method is too often unapplied. In European countries men of high scientific rank are frequently found in legislative bodies and ministries; men like Playfair, Roscoe, and Lubbock in England, Virchow in Germany, Quintino Sella in Italy, and Berthelot in France. With us in America the maker of speeches outranks the thinker in popular esteem, and is given duties to perform in which he may become ridiculous. Both in legislation and in diplomacy many questions arise which demand the most careful scientific treatment, or which can be answered only by thorough scientific knowledge, and many of these have been intrusted for settlement to men of no specific training whatever. Of late years we have had the fur-seal controversy, the question of forest reserves, the irrigation of our arid lands, problems of sanitation and water supply, and in each of these the man of science has played a part which was too often subordinate to that of the politician. In an ideal government the two should work together, each supplementing the peculiar ability of the other. Many details of the tariff, and a notable part of the coinage question, require scientific data for their proper settlement, but the true expert has not always been consulted. The result of this neglect is sometimes seen in courts of law, where questions of interpretation arise which might have been averted, obscurity in legislation being often due to the careless use of scientific terminology or to ignorance of the relations in science between two branches of industry. The voice of the trained investigator might well be heard in Congress, but his testimony now is limited to the committee room. Even there it is received with an attention which is too often mingled with incredulity. The myth of the dreamer, the visionary, is more than half believed.

The supposed type, then, is not a type, but an exception—a man of straw, which is hardly worth overthrowing. But the belief in it has been and still is mischievous, a hindrance to wise action, an obstacle to progress. The misconception has worked injury to science. These words of protest, therefore, are not wholly superfluous.

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FORENOON AND AFTERNOON.

BY CHARLES F. DOWD, PH. D.

It is a fact of common observation, at different times of the year, that the forenoon and afternoon, as to daylight, are of unequal length. Along in later autumn the shortness of the afternoons is very noticeable, and the shortness of forenoons along in later winter. Whatever makes common facts more intelligible adds to the general intelligence and to the general good. It is to this end that the following brief statements are made.

Nothing is more evident than that the sun requires just as much time to go from the eastern horizon to the midday meridian as to go from that meridian to the western horizon. But, strange to say, there are but four days during the whole year in which the sun reaches the midday meridian at just twelve o'clock. The true noon point varies from about fifteen minutes before to about sixteen minutes after twelve o'clock. These extreme points in one set of variations fall in the first week of November and in the second week of February, not to designate exact days for years in general.

The calendars show that in the latitude of Saratoga (essentially Boston latitude) on November 3, 1898, the sun rose at 6.30 and set at five o'clock, thereby making the forenoon a half hour longer than the afternoon. On that day the sun reached the midday meridian at 11.45. On February 13, 1899, the sun rose at just seven o'clock and set at 5.30, thereby making the afternoon a half hour longer than the forenoon, and on this day the sun reached the midday meridian at 12.15. These are facts plainly open to general view, and therefore need no verifying.

The causes of the foregoing are not so apparent to common observation. It must be borne in mind that the mean or average solar day is the basis for all time measurements, therefore its exact length is of the greatest importance. Yet the general solar day, from which the average one is derived, is a very indefinite term as to its length. Its length in general may be defined, under view of the sun's apparent motion, as the time extending from the instant that the sun's center crosses any given meridian of the earth on one day to the instant that center crosses the same meridian on the following day—i. e., the time intervening between these two instants is the length of a solar day.

The motion of the sun, however, is only apparent; the actual motion is in the earth's revolution upon its axis.
We should have one day a year long if the earth did not revolve on its axis at all, since the revolution of the 493
earth around the sun once a year would in the course of the year bring all sides facing the sun. Consequently the earth makes one more revolution upon its axis each year than the number of solar days in that year, and a little consideration of this fact will show that in each solar day the earth makes one full revolution on its axis and about 1/365 of another, which fractional addition is occasioned by one day's progress of the earth along its orbit.

Another fact needs to be considered. Since the earth's orbit is in the form of an ellipse, with the sun at one of the foci, the earth must pass nearer the sun in some parts of its orbit than in others. By the laws of gravity, when nearer, the attraction between the earth and sun is greater, and if this were not balanced by increased velocity along its orbit the earth would fall into the sun; and, on the other hand, when farther off this attraction is less, and if this were not balanced by a diminution of velocity along its orbit the earth would fly off into space. This varying velocity, together with other complications too technical for a magazine article, gives varying lengths of orbit to the several solar days of the year. If the earth's orbit were laid out upon paper and, by astronomical calculations, an exact proportionate section were marked off for each solar day of the year, the variable lengths of orbit for the different days of the year would plainly appear to the eye.

But, as before explained, the time of a solar day is the time of one revolution of the earth upon its axis, together with the fractional part of another revolution occasioned by one day's progress of the earth along its orbit. Then it must follow that as the daily sections of the orbit vary in length, the time of the solar day must vary in length. No clock could be made to keep the variable time of true solar days, and if this were possible, the hour, minute, etc., would be variable of length, and hence no standard for time measurements. But by working a simple arithmetical problem of addition and division an average length of day for the year may easily be found. This average day is the mean solar day adopted. Its time is arbitrary and exact, forming a perfect standard for all time measurements. From this the term *mean time* gains its significance.

By referring to the foregoing earth's orbit laid out on paper, with the true solar days marked off in sections of mathematical exactness, it will be seen that by dividing each section into two equal parts and marking the division point with red ink, the true noon point of each solar day in the year will be conspicuous upon the drawing, and in its proportionate relations in every way. If now we set a pair of dividers or compasses so that
the opening shall reach over the exact space on the orbit of one half of the mean solar day, and beginning at the 494
red noon point of one of the four days in the year when the true noon falls at just twelve o'clock—say December 24th—and step the dividers around on the orbit, making a blue point mark at each second step, then as the blue points vary from the red so will the mean time which our clocks keep vary from the true noon of each day of the year.

Variation in length of forenoon and afternoon, therefore, may be viewed by common intelligence not only as a fact but as a necessity.

PRESIDENT JORDAN'S "NEMINISM."

Office of the President, Leland Stanford Junior University,
Palo Alto, Cal.
Post Office, Stanford University .

Dear Dr. Youmans:

The inclosed, from an anonymous but appreciative source, may interest you. It is doubtless true that the philosophy of Neminism goes back to India, through Hegel and Plato, but the high priestess does not know this. She made it all out of her own head.

Truly yours,
David S. Jordan.

The University of Mentiphysics,
Lynn, Mass., *December 6, 1899*.

President David Starr Jordan, Leland Stanford University, California.

Sir: I have before me the last issue of one of our two or three great scientific magazines, in which Mr. Giddings lays down the exact method we are to follow in sociology, thereby creating the pleasing impression that hereafter he intends to stick to it himself. But, sir, I wish to say, as a student of "Neminism," as you call it, that my emotions were far less agreeable on perusing your brilliant plagiarism, the doctrine of *Nihil nemini nocet*, an aphorism which apparently you wish to make rival the *Cogito ergo sum* of the Cartesian philosophy. I will concede to you (I being, as it is perhaps necessary for me to remark, a literary person) the undoubted right all real literary persons have of appropriating everything of a literary nature that they can lay their hands upon; but, while we are in perfect harmony upon this occasion, in regard to that point, I regret to insist that the thing must be done judiciously—*that* is the art. Any mere plebeian can accumulate facts—*that* is the *raison d'être* of the plebeian; his duty is to work—but the real ethereal literary man, such as the monthly magazines nourish, must disdain facts and theories and the truth, and must float in the pure, soft twilight of his own imagination 495
while he writes about people who never existed, in a language which nobody can understand. Yet, sir, in your unblushing appropriation of the late Professor Hegel's dictum of *Sein und nicht Sein sind dieselbe* (which I presume you, sir, to exculpate yourself, will swear you do not understand), and in your changing that immortal antithesis to your *Nihil nemini nocet*—in doing all this I declare that you have violated one of the most sacred principles, in fact, the very essence of Neminism; for to say, as you have said, that nothing hurts nobody, is to say a very dull, prosaic, vulgar fact which any fool can understand; but to say that "to be and not to be are the same" is to say something that is not only very beautiful, but, what is far more to the point, is likewise utterly incomprehensible; yet to do this *is* the essence of Neminism, as you yourself have shown.

As a confirmed Neminist glorying in his Neminism, as Pascal's Father Joseph, the Jesuit, gloried in "interpretation" of the words "murder" and "charity," I am, sir (and I hope my frequent use of this monosyllable will not annoy you, for the first Neminist, Plato, uses Ω Σωκρατες [Greek: Ô Sôkrates] quite as frequently, though his expression requires four times as much wind or space as mine), I say, then, that I am always anxious to be thought well of by people who are on top or are getting there, in order, to use your own undignified and cruel metaphor in the Rev. Mr. Lyman Abbott's journal of news and Christianity, that I may continue "to hold down" my position as the janitor and Professor of Leibnitzian Monadology in the University of Mentiphysics. But there are times, sir, when even a feminist rises above his interest, and, like Richelieu in the play, exchanges the lion's and the fox's skins. In short, I beg to inform you that I believe that you, seeing the growing attachment of the vulgar mob for the *Wissenshaftliche Pädagogie* of the Robinson Crusoeans or concentrationists, have had the thought to sap the foundations of their success by vulgarizing our noble monopoly of Neministic science, and I should not be at all surprised to see your name, after a little, as the editor of a "Journal of Psycho-Materno-Kinder Apperceptics," or of a strictly American "Great Educator Series," beginning with Pontiac and ending with Jim Fiske.

Or perhaps, sir, you are actuated by deeper motives. Our university has not yet received the complimentary copy of your work on Imperial Democracy, the Government probably holding it back until General Young can catch Mr. Aguinaldo, but I see by the publishers' lists that it is out. Now, it is easy to see that if Imperial Democracy gets within a stone's throw of China it will get *into* China, and, with your knowledge of Aristotle's
Politics and the Highbinders in Chinatown, you can not have failed to have recognized that Neminism and 496
Orientalism are very similar. To be or not to be; to be alive or to be dead; to be drunk or to be sober—'tis all the same for the people; 'tis *Nirvana*. You wish to vulgarize Neminism. What follows your success? Immediately every State will make it an obligatory study in the public schools, and when, in the distant future, we meet the Chinamen face to face, we will be ready to exterminate them or be exterminated by them; for it is an axiom of sociology, which it is to be hoped Mr. Giddings will see the value of and will in the next edition of his Social Euclid make number one, that when two societies completely differing in origin, history, manners, institutions, and laws come together they start in the more quickly to cut each other's throats when they have a common idea in which they can locate a difference, and hence find a logical excuse to begin.

I would have preferred that our president had taken up this unpleasant task of criticising your mischievous efforts to vulgarize our beautiful science, which, like the true religion of the Egyptians, should be retained *sub rosa* in the temples; but she, as you yourself have said, does not like controversial publicity, and has often remarked that our science is like the mushroom, for, though it is the child of darkness and Byzantian filth, it is eminently adapted to be retained by weak stomachs, while for others it may be nauseating. I am, sir, very respectfully,

Anacharsis Pangloss, *M. Plane*.

Though religiously refraining from introducing my own personality in the foregoing, it being a cardinal point

in our science that it is good form to appear modest—*videri quam esse*, as was said of Cato—I am, nevertheless, obliged to observe that I am not at all in any way related to the Dr. Pangloss, LL. D., A. S. S., mentioned in the play of the Heir at Law, nor yet, though perhaps more spiritually akin, to that other Dr. Pangloss—Dr. Leibnitz Pangloss, the tutor of Candide mentioned by the late Monsieur Voltaire of happy memory. Dr. L. Pangloss, a fine old fellow at bottom, was engaged in showing how, in the best possible words, a cause always precedes its effect; for instance, Monsieur the Baron Thunder den Trockendorf has a nose, argues he—it will carry spectacles, hence the nose was created for spectacles, and spectacles are created. It is plain that Dr. L. Pangloss was a scientist. Now, I am a sociologist, and it is the hope of my life to fill the chair of Monadology in the new American university, where I intend to show that while the rich are becoming richer the poor will become richer than the rich in contemplating how much more satisfaction the rich get out of their riches than 497
they, the poor, get out of their poverty. This, as you will at once recognize, is in the line of what Mr. Lester Ward calls Dynamic Sociology, and, though it is not the acme of the application of dynamics such as that which knocked Hebraism out of Saul of Tarsus, I beg to remind you that, until German science has made further progress in the application of electricity, we lack the means of producing the necessary phenomena by which alone such effects can be secured.

A. P.

Correspondence.

FAITH AND KNOWLEDGE.

Editor Popular Science Monthly:

Sir: In your editorial, in the issue of September, you speak of “faith as the organ of religious apprehension.” This suggests some important facts that are not always apprehended, or are forgotten. There is no organ for the discovery, the proof, or the apprehension of truth but reason, whether facts of Nature or of religion. “Faith” is not a sixth sense which we do not use in scientific pursuits, but which comes to our help when we seek for religious truth. Much of the difficulty comes from the fact that the word “faith” is ambiguous, having two meanings, which are not distinguished. It is (1) simply belief of a fact because of evidence presented to and apprehended by the reason; or is it (2) trust, confidence in, belief in, as in a person, resting on the belief of that person’s competency and truthfulness, that belief resting on evidence apprehended by the reason. Because of this “faith” in the person we accept his testimony as to facts beyond our personal cognizance, we believe them not because we have discovered them, or may be are competent to discover them, but because of our “faith” in a person whom we have seen reason to believe is trustworthy—i. e., competent and truthful.

Now, these two meanings of “faith” are often confused, interchanged. Hence the discredit thrown upon belief of religious truth, because an illegitimate use is made of the place of “faith” in its justification. And writers defending religious belief have been great sinners in this illegitimate use of “faith.”

The place of “faith” is the same in science as in religion—i. e., it is the condition and justification of our acceptance of truth which is beyond our personal cognizance. We accept it because of the testimony of men in whom we have learned to have faith—e.g., How few of us who accept the revelations of the spectrum analysis as to the composition of the stars have any other justification for accepting them than just this? We believe them simply because men, whom we, in the exercise of our reason, have come to believe competent and truthful, tell us what they have seen. We believe on their testimony because we trust them. Our process involves three steps: (1) Belief of their competence through appeal to reason; (2) trust in them because of this belief; (3) belief of their testimony because of this trust or “faith” in them. The only organ we have used is reason, in its initial act of belief of the competence and truthfulness of the witnesses. Error in the use of reason here vitiates all that follows. Correct use of reason here gives a legitimate condition for correct results of the other steps. But reason must go along with us and guide us in these, that we may come to a rationally accepted belief of the truth.

Here is the place of “faith” in science, as belief and as trust. By its use we accept the great issues of scientific truth which we believe, and do it legitimately.

It is the same in all right acceptance of religious truth. Here appears a person in human history claiming to reveal facts beyond our sphere of cognizance. Now, the first (1) step is belief in his competence and 498
truthfulness as a witness, just as in cases of science. His only appeal is to reason, our only organ for apprehending truth. We, because of the evidence presented to our reason, believe him competent and truthful—i. e., trustworthy—and we take the second step (2), as in case of search for scientific truth. We trust him, we have “faith” in him. Then (3) we believe his testimony as to facts beyond our cognizance, as to God, as to the inner world and life, as to his own person and work, and his agency in helping us to the true life. Here are the same three steps as in our believing the great facts of science, and they are equally legitimate, and the belief is equally legitimate, and with the same use of “faith” in both cases, which use is legitimate if we have applied our reason correctly.

It may be said that there is this difference in the two cases: We are, it may be, competent with training to perceive with our reason the facts to which the scientists witness, whereas in religion we are not competent by any training, in our present state, to see what Jesus Christ testified to; therefore the believing him is not legitimate.

Space forbids arguing this point, but the writer is confident it can be shown that this does not vitiate the process in the least. The only point now argued is that reason is the only organ of man for the apprehension of truth, and that “faith” acts the same part in scientific and religious belief.

John R. Thurston.

Whitinsville, Mass., *September 30, 1899*.

[The point which our correspondent discusses is one which falls rather within the province of theology or philosophy than within that of science. In the article to which he refers we did not distinctly say that “faith” was “the organ of religious apprehension.” What we said was that *granting* such was the case, the question still remained to be settled where the line should be drawn between faith and knowledge. We doubt whether the account which our correspondent gives of faith would be widely accepted by those who approach the subject from the theological side, while those who approach it from the scientific side would—at least many of them would—be disposed to consider the term one which might better be dispensed with in favor of the less ambiguous word “belief.” Belief is the inclination of the mind toward a proposition for which absolute or demonstrative proof is wanting, and it is this condition of mind, it seems to us, that our correspondent has in view. Faith in the religious sense, unless we are mistaken, is something different. It is an affirmation made by the human conscience or consciousness in its own behalf—a certain instinctive recognition of a presence and power in the universe which, though inaccessible to scientific investigation, sustains an intimate, profound, and all-essential relation to man’s moral nature. If trust in an individual ever rises to the level of faith in this sense, it is because the influence of the individual harmonizes with and re-enforces the primal instinct. That, at least, is how we view the matter.—Editor.]

FISKE'S VIEWS COMPARED.

Editor Popular Science Monthly:

Sir: Will you permit me to say a few words supplementing your review of Through Nature to God? To those who have perused Mr. Fiske's latest three scientifico-theological booklets, and also his Cosmic Philosophy, it can not be new that their author has become entangled in hopeless contradictions of himself. The limited space of a letter does not allow of adducing more than one remarkable passage from Cosmic Philosophy, demonstrating the antithesis between the arguments of this work and Mr. Fiske's latest opinions, these new thoughts having been developed, as he tells us, by "carrying such a subject about in his mind for" twenty-five years. We are told in Through Nature to God (page 12) that "it has usually been found necessary to represent the Creator as finite either in power or in goodness, although the limitation is seldom avowed, except by writers who have a leaning toward atheism and take a grim pleasure in pointing out flaws in the constitution of things. Among modern writers" Comte and Mill are conspicuous for such a "leaning toward atheism." Then we are informed (page 20) that the "shock which such a clear, bold statement gives to our religious feelings is no greater than the shock with which it strikes counter to our modern scientific philosophy." And a little further on we find that "the God which Mr. Mill offers us, shorn of the attribute of omnipotence, is no God at all."

If the reader will now open Cosmic Philosophy, he is told in vigorous language (vol. ii, p. 405) that "if there 499
exist a personal Creator of the universe who is infinitely intelligent and powerful, he can not be infinitely good; if, on the other hand, he be infinite in goodness, then he must be lamentably finite in power or in intelligence. By this two-edged difficulty, theology has ever been foiled." Then (vol. ii, p. 406) Mr. Fiske, quoting from Mill, expresses his entire concurrence with the views of this eminent thinker, and adds (vol. ii, p. 407), "With Mr. Mill, therefore, 'I will call no being good who is not what I mean when I apply that epithet to my fellow-creatures.' And, going a step further, I will add that it is impossible to call that being good who, existing prior to the phenomenal universe and creating it out of the plenitude of infinite power and foreknowledge, endowed it with such properties that its material and moral development must inevitably be attended by the misery of untold millions of sentient creatures for whose existence their Creator is ultimately alone responsible."

No comment of mine can show more clearly than the passages cited above the "conversion" of Mr. Fiske, against which imputation so much subtle ingenuity is expended in the preface to The Idea of God.

That Mr. Fiske is merely reviving gross anthropocentric views he himself admits. To him, man is "the goal toward which Nature's work has been tending from the first." But might not also some pithecoid ancestors of ours have deemed themselves the "goal toward which Nature had been tending from the first"? What is Nature's goal in the endless cycle of evolution in which life is but an infinitesimal part? But with Huxley I believe that "it would be a new thing in history if *a priori* philosophers were daunted by a factious opposition of experience." Mr. Fiske's latest writings, as all theodicies, bear testimony to the truth of Huxley's scathing remark.

But granting, for the sake of the argument, that "in the deepest sense it is as true as it ever was held to be, that the world was made for man," there is an objection to be raised on moral grounds stronger than any that could be founded on scientific arguments. Had this world been created for man, entailing, as it does, the "misery of untold millions of sentient creatures," who but the crassest egotist could worship this Fiskean God of iniquity?

The careful student of Thomas Huxley's works may be surprised to find Through Nature to God "consecrated" to the memory of him whose life work was devoted to "untiring opposition to that ecclesiastical spirit" that shines through every page of Mr. Fiske's latest writings. I echo Mr. Fiske's words: "I can never cease to regret that Huxley should have passed away without seeing my [Mr. Fiske's] arguments and giving me the benefit of his comments." The last stroke of Huxley's pen was giving Mr. Balfour "the benefit of his comments"; would that he could have given them to the author of the excursion Through Nature to God!

B. A. Behrend.

Erie, Pa., *December 5, 1899*.

Editor Popular Science Monthly:

Sir: Your trenchant criticism of Mr. John Fiske's discussion of the mystery of evil recalls Mr. Spencer's reminder that "there is a soul of truth in all things erroneous."

Mr. Fiske certainly has not made it plain that the meaning of the universe is to be found (exclusively) in the higher developments of love and self-sacrifice; but is it not equally a mistake to say inferentially that "on a broad view of the world-wide struggle for life there are no moral elements to be seen"? If we define morality as the equivalent merely of love and self-sacrifice, the ever-present love of mother and, in a degree, of father for the offspring imperatively negatives such a conclusion.

But morality is something more than love and self-sacrifice. Morality is right conduct, and right conduct in the last analysis is conformity to the conditions of existence. The nearer the conformity, the more complete the life, and life approaches completeness only as the activities of men cease to be impeded by each other's aggressions, the highest life being reached when men help to complete one another's lives.

Conversely, evil must be defined as nonconformity to the conditions of existence. Slowly but surely man is
learning these conditions, and as he learns it is not to be doubted that "evil" will lessen. If we affirm acquisition 500
of knowledge by man, we must postulate a precedent or "necessary" condition of ignorance. Hence it may be truthfully said that evil is a necessary correlative, and in a manner the necessary condition of good; and also, I think, that a broad view of the worldwide struggle for life shows not an absence of moral elements, but rather that the ethical is inherent in the very nature of animate things.

We may not all share Mr. Fiske's exuberant optimism, and many can not accept his teleological implications, but of the ultimate triumph of good over evil, of knowledge over ignorance, we may not doubt.

FRANK M. LOOMIS.

BUFFALO, *November 10, 1899*.

THE LOCATION OF VINLAND.

Editor Popular Science Monthly:

SIR: I beg to take exception to the exploded Boston theory again revived by Miss Cornelia Horsford in the last number of your valuable magazine. It is astonishing to notice how little Prof. G. Storm's excellent prize essay and Mr. Reeve's careful edition of the text of sagas seem to have availed against the misplaced patriotism that persists in carrying those Norse explorers down to New England in the face of the numerous difficulties with which this feat is associated. If I am not mistaken, not a single historian or antiquarian of note has taken Professor Horsford's extremely unscientific treatment of the sagas or his Norse discoveries seriously, and the sober verdict of Mr. Thorsteinn Erlingsson and Dr. V. Gudmundsson on the alleged Norse ruins seems to show that Miss Cornelia Horsford has met with no better success. To refute all the philological curiosities and illogical conclusions drawn by Professor Horsford in his ten treatises on the subject would, however, require a book of at least five hundred pages, and nobody seems to think the question important enough to warrant such an output. The fact that Mr. A. H. Keane, in his recent work, Man, Past and Present, takes it for granted that the Norsemen met with Eskimos in New England in the year 1000 seems to prove, however, that this persistence in defending a baseless supposition is not merely a matter of innocent patriotism. Fortunately, the current year, which marks the nine hundredth anniversary of the discovery, will be sure to see some valuable new treatises on the subject, and those who are sufficiently interested furthermore need only consult the above-mentioned books to discover how many serious objections the New England theory really has to contend with. Permit me to mention one of them. Cape Cod has, it is true, one singular feature that suggests the Keel Cape of the best version of the Vinland manuscripts—viz., sandy shores. As everybody can see for himself, however, by consulting Mr. Reeve's book, the explorers sailed south from Keel Cape on the eastern shore till the country became indented with bays. At the mouth of one of these they established their first winter quarters (the so-called Streamfirth), and the next fall proceeded still farther south for a considerable time till they came to "Hop," the true Wineland. The extraordinary ease with which Professor Horsford, in his book Landfall of Leif Ericson, undertakes to chop up this version, in order to make the explorers return to Boston from Cape Cod instead of continuing on their course, is something remarkable in the annals of historical research. But even then his theory fails utterly to satisfy the critical reader. The trouble with most of the writers on this subject, not excluding a professional historian like Prof. John Fiske, is that they have failed to sift the material or see the force of Professor Storm's criticism of the Flat Island version. This being done, everything falls into line for the Nova Scotia theory, due consideration being given to the fact that an oral tradition of at least one hundred years intervened between the events narrated and the first somewhat extended written record.

While, therefore, owing to the last-mentioned fact, it is not altogether impossible that the Norsemen reached New England, it should be distinctly understood that such a conclusion can only be drawn on archæological lines, the test of the sagas pointing clearly in the opposite direction.

JUUL DIESERUD.

FIELD COLUMBIAN MUSEUM, CHICAGO,
December 7, 1899.

Editor’s Table.

THE WAR SPIRIT.

It must be a matter of deep regret to all right-thinking men that there should have been during the latter half of the century now expiring so marked a revival of the war spirit. In the middle of the century it was thought by many that the world had learned wisdom from the terrible experiences of the past, and that with the development of international trade war would become an outworn mode of settling international controversies. How different a turn things were destined to take need not here be told. Coming to recent events, however, we may say that it is lamentable our own country could not have won by peaceful means whatever advantages it has secured by its recent war with Spain. Equally lamentable is it that Great Britain, the other great representative of Anglo-Saxon civilization, should at this moment be engaged in a still bloodier struggle over questions which it is hard to believe could not have been settled by negotiation. “Whence come wars and fightings among you?” is a question that was asked very long ago, and we do not know that it is possible to improve on the answer then given: “From your lusts.”

We do not say that a nation should not resist to the death a distinct aggression on its liberties or its independence. We do not say that when horrors are being enacted in any part of the world force may not righteously be employed to arrest them; but it is clear to our mind that, in the present age, wars between civilized countries might be almost wholly avoided if more reliance were placed upon moral force and less rein given to the impulse to employ physical force. This is a matter for the people in any state enjoying free institutions to take to heart. Let every man in a time of national difficulty ask himself this question: “Do I personally want to have blood shed over this matter?” Or this one: “Am I personally indifferent whether or not this dispute ends in bloodshed?” If a nation or the majority of a nation wants to have blood shed over a dispute with another nation, or is indifferent as to whether that shall be the outcome, the discussion will be carried on in a very different spirit from what it would be if there were a pronounced aversion to such a result. With nations, as with individuals, everything depends upon the spirit and ulterior purpose with which a question is approached. The cases must be very few in which a great nation, safe itself from attack, might not, in any matter in which minor interests are involved, resolve within itself that it will not resort to war—that it will work, and continue to work, on moral lines, trusting that, if it has right on its side, it will in due time carry its point. If blood cries from the ground against the slayer, what must be the responsibility of those who heedlessly and ruthlessly give their voices for war, when patience, moderation, and disinterestedness would have better accomplished every legitimate purpose? Slaughter is slaughter, murder is murder, however we may seek to weaken their import by a conventional treatment. War is mutual murder carried on professionally and systematically. Yet the primal command still makes its solemn appeal to the human heart and conscience: “Thou shalt not kill.”

It is, unfortunately, only too easy to cultivate the military spirit in almost any nation, and the military spirit, 502
it need hardly be said, is the spirit that seeks quarrels. To the military man war means excitement, emulation, reputation, promotion, subject of course to the possibility of injury or death. No one denies that deeds of heroism and self-devotion are done on the battlefield; but that men should acquit themselves nobly in the field is no compensation for the horrors of a war brought on by the predominance of the military spirit.

“‘Great fame the Duke of Marlborough won,
And our good Prince Eugene.’—
‘Oh, ’twas a very wicked thing,’
Said little Wilhelmine.”

And every war is wicked and detestable that could consistently with national honor be avoided. When we say “honor” we do not mean “reputation.” Reputation depends on the canons of judgment prevailing among those who presume to award it. In a dueling community a man’s reputation might suffer by declining a challenge, but his honor would be intact if he declined from sincere unwillingness to do a wrong act. There is much honor sometimes in sacrificing reputation, particularly the “bubble reputation” that is won “in the cannon’s mouth.” Every appeal to the sword weakens the reliance placed upon principles of justice, and thus undoes a vast amount of the work of peace. When war is once set on foot, the national judgment is more or less blinded. True, it is the action of a majority of the people only—admitting that a majority wanted it—but who is uncompromising enough, when his country’s armies are in the field, to proclaim that they are fighting in a wrong cause? A few may do it, but they do it at their peril. In all other matters a minority may censure with any degree of severity the policy of the majority, but not in the matter of a war once entered on. Yet how perverting such a situation is to right judgment, and how injurious an effect it must have on the rising generation, are only too apparent.

These reflections may not at first sight seem to have a very direct bearing on the interests for which this magazine is supposed to stand, but to our mind science, in the broad sense, has no function so important as that of settling the education of the young upon a right *moral* basis. No system of education deserves to be called scientific that does not place the idea of justice at the very foundation of human life. You can not do this, however, without making it a working principle, and without inculcating a belief in it as such. Applying the principle to national affairs, we see at once that a strong nation which desires to be just will take no advantage of its strength in its dealings with other nations. If it has a demand to make, it will make it simply in the name of justice, and cast no sidelong glances at its up-to-date battle ships or its well-equipped battalions. It will have unbounded patience with weaker communities, which, rightly or wrongly, may seem to think they have right on their side. It will not be ashamed to shrink from the shedding of blood. The “young barbarians” of our public schools are always only too ready to exalt might above right; but the judicious teacher into whom the true spirit of science has entered will seize every favorable opportunity for inculcating the great lesson that the moral law has a way of vindicating itself in the end, and that the inheritance of the earth has been promised not to the quarrelsome or the overweening, but to the meek. A generation brought up on these principles would be slow to make war, and their influence on the world would be in every way powerful for good. 503

LANGUAGE AND LIFE.

The ordinary school education in language and grammar is doubtless responsible for the impression which we find existing in so many minds that, in all matters of verbal expression, there is some one absolute standard of authority to which it implies simply ignorance not to bow—some supreme court, as it were, empowered to decide for us what words we are to use, how we are to pronounce them, and what rules of syntax we are to follow. It would be difficult, doubtless, to impart to children or very young people the wider and more scientific view of language, inasmuch as they need, in the first place, clear guidance as regards usage rather than correct theory. The idea, therefore, with which they grow up, if their school studies take any hold upon them at all and if no wider culture comes to change their way of looking at things, is that some very wise man made an infallible grammar and another very wise man an infallible dictionary, and that no one need be in doubt in regard to what is orthodox in language who has access to these tables of the law. We have known grown-up persons to turn away with a very skeptical air, and a kind of look as if they had found out a weak spot in your educational armor, when they were told that really it was impossible to say which of two pronunciations of a word was right and which was wrong—that either might be employed without mortal offense against elegance of speech or good breeding.

A hidebound view of language tends so much to narrow thought on general subjects that it seems to us of importance that the true and scientific view of the subject should be brought forward whenever opportunity offers. Mr. William Archer, the well-known English critic, contributed an article not long ago to the Pall Mall Magazine which might be read with much advantage by pedants and purists, and all blind followers of authority. He takes the broad ground that language is a transcript, as it were, of life, and that as life widens and becomes more varied, language must do the same. It must reflect the fancy, the imagination, and the humor of the day, and not merely the fancy, imagination, and humor of past generations. If we want a language that is fixed and unalterable in its forms we must seek one that has ceased to be spoken by men. Even then we can not always get absolute decisions. Cicero is perhaps the best standard of Latin prose, but no competent critic would say that his writing was flawless. We know that grammatical questions were much debated among the ancients, and we have no doubt that many such questions were left unsettled. In a living language there must be unsettled questions. There is a constant struggle for life going on among the words and phrases with which men endeavor to express their ideas, and, at a given moment, it is impossible to say which shall prosper, this or that. The word or phrase that prospers—that commends itself, after adequate trial, for expressiveness, convenience, or euphony, or for any combination of useful qualities—will survive and become classic; the expression that has nothing special to commend it, beyond its novelty and slanginess, will probably pass, after a brief and partial currency, into the vast limbo of the unfit. All we can say of a word at a given moment is how far it has actually become current and what kind of society it keeps. What its fortune will be we can only guess. Just as in the financial world great fortunes are sometimes very suddenly made and names before obscure spring into world- 504
wide notoriety, so, in the realm of language, a word of very uncertain ancestry and no social repute may assert its right to recognition and take its place among the best.

It does not follow from this that it can ever be a matter of indifference what words we use or what tricks we play with language, any more than it can be a matter of indifference what personal habits we adopt. Language is the clothing of our thoughts, and as such it may exhibit the same qualities which attach to the clothing of our bodies. It may be marked by neatness and propriety, or by slovenliness and want of taste. Some men are over-dressed, and some affect over-fine language. Some go after the latest novelties in the tailoring world, and some after the latest slang, asserting thereby their resolution to be up to date. It is needless to draw the parallel further, but it is evident that there is wide scope in the choice of language for the exhibition of personal preference and personal character. We think it safe to say that the interests of a language, considered as an instrument of thought, will be best promoted by those who pay due respect to its established forms, and only countenance such neologisms as make good their claim to acceptance by supplying a real want. Mr. Archer, in the article we have referred to, states, and we do not doubt with truth, that the English language has been greatly enriched and strengthened by the fact that it has been spoken and written by millions of people on this side of the Atlantic, leading an intense and vigorous life of their own, under conditions very different in many respects from those prevailing in the mother country. The language moves with a freer step, beats with a stronger pulse, and assumes a more imperial bearing from the fact that it expresses the activity and sums up the life of the foremost communities of the human race in both hemispheres.

A great classical scholar not long ago wrote a letter to an English weekly newspaper expressing a very contemptuous estimate of the French language, as being only a degraded form of Latin. He thought it a great disgrace to the language that it had no better word for “much” than *beaucoup*, which, as he learnedly explained, came from two Latin words meaning “fine” and “blow.” The most cursory examination of any language will show that it abounds in just such verbal devices. We do not in English put the words “great” and “stroke” together, but, using them separately, we say “a great stroke” of luck and of many other things when there is no question of “striking” at all. In the same way we would say “a great hit,” when there is no question of hitting, except by remote analogy. Languages grow rich and flexible precisely by the adoption of such convenient combinations. What they may originally have meant becomes a matter of little moment when once they have become thoroughly accepted and thoroughly expressive. After they have become welded together, as sometimes happens, in one word, it is an advantage rather than otherwise if the separate meanings of their constituent parts become lost to all except the professional etymologist. As long as the separate parts retain their separate meaning some sense of incongruity will sometimes arise in connection with the use of the term. Thus to say “a handful of corn” is all right, but one might feel that it was not all right to say “a mere handful of men.” Yet it would be futile to criticise the expression which has become idiomatic English. If the word 505
“handful” had parted with its essential meaning as completely as say the word “troop” has, for all but etymologists, there would be no kind of incongruity in its employment for any small number or quantity

whatsoever.

The scientific view of language, then, is that it represents the effort of mankind to use audible symbols for the expression of thought; that it follows the development of man’s activity and enlarges with his enlarging knowledge, and comprehension of things; that while its object is essentially a practical one it gathers beauty with use and age, and begins to react on the minds of its makers; that its makers are the people, not the grammarians, these being merely its policemen, who, useful in general, are sometimes too officious; that great writers are the architects who felicitously arrange materials which the people have gathered and shaped, placing the best of such materials where they can be seen to best advantage; finally, that the language of each nation is its most precious possession, the record of its civilization, and the repository of all that is best in its moral and intellectual life, and that it is therefore the duty of all who make any pretensions to liberal training to watch over their heritage and, while allowing all reasonable scope for further development, to guard it by all means in their power against degradation and pollution. A great people will have a great language: when a language shows signs of weakness or declension, there is reason to fear for the civilization of which it is the expression.

Fragments of Science.

“Dark Lightning.”—The attention of meteorologists and photographers has been engaged to a considerable extent, within a few months past, with the appearance on photographs of lightning of what seemed to be dark flashes as well as bright ones. In the effort to account satisfactorily for the phenomenon it has been referred to photographic reversal, due to extreme brilliancy; to a predominance of infra-red radiations; to the existence of flashes deficient in actinic rays; to changes in the density of the air occasioned by the spark, when a dark line with a light line within it is shown if the air is compressed, and a light line inclosing a dark one if it is rarefied; and to some qualities of the photographic plate. The first real light was thrown on the subject by some experiments described by Mr. A. W. Clayden, who, having photographed some electric sparks of different intensities, before developing the plates exposed them to the diffused light of a gas flame. The brilliant sparks then yielded images which might either be called normal with a reversed margin, or reversed with a normal core, while the fainter images were completely reversed—or, in other words, came out darker than the background. The “fogging” of the picture, to produce this reversal, must be done after the image of the flash is impressed; for if it is done before, the image appears lighter than the background. This effect, which is called the “Clayden effect,” is accepted as a satisfactory explanation of the phenomenon by two of the authors who have most studied it—Dr. W. J. S. Lockyer and Prof. R. W. Wood, of the University of Wisconsin. Professor Wood, on repeating Mr. Clayden’s experiment, obtained dark flashes without any difficulty, but as they failed to appear when the light of an incandescent lamp was substituted for the electric spark, he concludes that there is something in the spark essential to the reversal. Dr. Lockyer summarizes his conclusion by saying that dark-lightning flashes “do not exist in Nature, but their appearances on photographs are due to some chemical action 506
which takes place in the gelatin film.”

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“Warming Up.”—“Warming up” is the expressive term of general currency, which Dr. E. G. Lancaster adopts to denote the process in which one starting on any work in a little while suffers a short period of fatigue, from which he soon recovers, to go on with new and increased vigor. This occurs in the course of walks, with students engaged in earnest reading or in writing, and in animals, as in dogs on the chase, the animals pursued, and racehorses. “It is said of two famous trotters, each of which has reduced the world’s record within a few years, that the period of warming up was very characteristic.... Athletes, especially ball players, realize the importance of practice just before the games, to be followed by a slight rest. A pitcher would hardly enter the box till he had got his arm in working order by a few minutes’ practice. Orators often are dull at first, but warm up. It is said that Wendell Phillips was often hissed for his slow, uninteresting speech, but rallied to the occasion at such times with his masterly oratory.” Dr. Lancaster has experimented on the phenomena, using a method like those of Mosso and of Lombard in the psychological laboratory at Clark University, and publishes the results, with details and curves, in the papers of the Colorado College Scientific Society. He tried ten or twelve subjects, experimenting on the middle finger of the right hand, and gaining most of his results from four or five persons. He finds that warming up is general, but not universal. One subject always did his best work first. He likewise showed no warming up in his mental work. The phenomenon called “second mind” is closely allied to warming up, but is not the same. The author is of the opinion that the importance of this process is greatly misunderstood.

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Sixty Years’ Improvements in Steamships.—A review of what has been accomplished in sixty years in the improvement of transatlantic traffic, given by Sir William H. White in his address at the British Association on Steam Navigation at High Speeds, shows that speed has been increased from eight and a half to twenty-two and a half knots an hour, and the time of the voyage has been brought down to about thirty-eight per cent of what it was in 1838. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The number of passengers carried by a steamship has been enlarged from about one hundred to nearly two thousand. The engine power has been made forty times as great. The ratio of horse power to the weight driven has been quadrupled. The rate of coal consumption per horse power per hour is now only about one third what it was in 1840. Had the old rate of coal consumption continued, instead of three thousand tons of coal, nine thousand would have been required for a voyage at twenty-two knots. Had the engines been proportionately as heavy as those in use sixty years ago, they would have weighed about fourteen thousand tons. In other words, machinery, boilers, and coal would have exceeded the total weight of the Campania as she floats to-day. “There could not be a more striking illustration than this of the close relation between improvements in marine engineering at high speed. Equally true is it that this development could not have been accomplished but for the use of improved materials and structural arrangements.”

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American Advances in Forestry.—The Department of Agriculture having determined to prepare a book for the Paris Exposition, reviewing what has been accomplished in scientific agriculture in the United States, the Division of Forestry will contribute to it a short history of forestry in the United States, with an account of the efforts of private landholders to apply the principles of forestry. Much more has been accomplished in the United States in the way of forestry than has been supposed. Mr. Pinchot, the forester of the division, holds that wherever private owners have made the effort to use the merchantable timber on their woodland without injuring its productive power, and to establish new forests, there has been the intention of true forestry. The methods may have been imperfect, but they have tended toward economic forest management so far as their 507
object was the continued use of the land for producing woods. Among the measures looking in this direction Mr. Pinchot mentions in his circular the practice which has been adopted “because it pays,” in some of the spruce lands of the Northwest, of leaving the small trees standing, so that the lumbermen can return for a second crop earlier than would otherwise be possible; and the adoption by farmers of methods in getting their wood, for

saving the best trees and promoting their growth and that of the new ones; of keeping sprout lands to be cut over regularly and systematically, for periodical renewal, and of tree planting on waste places, hillsides liable to be washed, and the banks of streams. Other forms of planting are the institution of wind breaks in the treeless West, and special plantations for fence posts, etc. A kind of forestry practice is likewise indicated in the special pains that are taken by farmers and in lumbering districts to lessen the danger of fires. Forester Pinchot desires that all the information that can be gained be communicated to him for the proposed article.

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Professor Putnam on the Origins of the American Races.—In his address as retiring President of the American Association, Prof. F. W. Putnam, after expressing his high opinion of the late Dr. D. G. Brinton and his scientific labors, referred to the differences of opinion that had existed between them in respect to the origin of the American peoples, and proceeded to expound his own views on the subject. He regarded the term "mound-builders" as comprehensive enough to include all the peoples who had left the marks of their former presence in this country. Even the shell heaps could not be regarded as the work of one people. From the time of the earliest deposits—which were of great antiquity—to the present, such refuse piles had been made and many of the sites reoccupied, sometimes even by a different people. So with the mounds of earth and stone; many of them are of great antiquity, while others were made within the historic period, and even during the first half of the present century. These works were devoted to a variety of purposes, and there are many different kinds of them. Besides the mounds, there are groups of earthworks of a different order of structure, that must be considered by themselves—great embankments, fortifications, and singular structures on hills and plateaus that are in marked contrast to the ordinary conical mounds, and mounds in the form of animals and of man. The considerable antiquity of these older earthworks is proved by the accumulation of mold and the forest growth upon them. "If all mounds of shell, earth, or stone, fortifications on hills, or places of religious and ceremonial rites, are classed, irrespective of their structure, contents, or time of formation, as the work of one people, and that people is designated as the 'American Indian' or the 'American race,' and considered the only people ever inhabiting America north and south, we are simply ... not giving fair consideration to differences, while overestimating resemblances." Citing analogies between our earthworks and Mexican structures, and looking upon the Pueblos as a connecting link, "we must regard the culture of the builders of the ancient earthworks as one and the same with that of ancient Mexico, although modified by environment. Our northern and eastern tribes came in contact with this people when they pushed their way southward and westward, and many of their arts and customs still linger among some of our Indian tribes. It is this absorption and admixture of the stocks that has in the course of thousands of years brought all our peoples into a certain uniformity. This does not, however, prove a unity of race."

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Heat Insulators.—Mr. C. L. Norton has made experiments, at the request of Mr. Edward Atkinson, in order to determine the relative efficiency of several kinds of steam-pipe covering now on the market; to ascertain the fire risk attendant upon the use of certain methods and materials employed for insulation of steam pipes; to show the gain in economy attendant upon the increase of thickness of coverings; and to find the exact financial return that may be expected from a given outlay for covering steam pipes. A method of experimentation was adopted which represented as nearly as practicable the conditions existing in the actual use of steam pipes. Of 508
sixteen non-conducting preparations tried, the most efficient were found to be those made of cork; next was a cover composed of an inner jacket of earthy material and an outer jacket of wool felt; and next magnesia. In reference to the last substance it is, however, observed that, while it is a most effective non-conductor, the name has been applied to many compounds of which the greater part consist of carbonate of lime or plaster of Paris, materials which are not good as heat retardents. Asbestos is merely a non-combustible material in which air may be entrapped, but, when non-porous, is a good conductor of heat. Generally speaking, a cover saves heat enough to pay for itself in a little less than a year at three hundred and ten ten-hour days, and in about four months at three hundred and sixty-five twenty-four-hour days. The decision as to the choice of cover must, however, come from other considerations, as well as from that of non-conductivity. Ability to withstand the action of heat for a prolonged period without being destroyed or rendered less efficient is of vital importance. The cork coverings were found to respond to this test extremely well, and there can be no question respecting magnesia; but Mr. Norton does not consider it safe to put upon a steam pipe wool, hair, felt, or woolen felt in any form, though the danger is not likely to accrue when an inch of fireproof material stands between the felt and the pipe. In general it may be said that if five years is the life of a cover, one inch is the most economical thickness, while a cover which has a life of ten years may to advantage be made two inches thick. The method of judging a pipe cover by the warmth felt on putting the hand upon it is fallacious; the sensation depends so much upon the nature of the surface that it utterly fails to give any idea of the actual temperature.

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Effect of Sea Water on Soil.—In a paper read at the British Association, 1899, on the chemical effect of the salts of the salt-water flood of November 27, 1897, on the east coast of England, Messrs. T. S. Dymond and F. Hughes recorded the remarkable result that, although the proportion of salt left in the soil was insufficient to prove injurious to growing crops, the earthworms were entirely removed, with the consequence that very few crops were worth harvesting the following year. In the next year nine tenths of the salt at first present had disappeared from the soil, and young worms had again made their appearance, but still the condition of the soil remained unsatisfactory, the rate of percolation of water through the flooded earth being only one half as rapid as through the unflooded. The authors ascribe this to the action of the chlorides of the sea water on the silicates of the soil with the formation of silicate of alumina in a gelatinous condition.

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The War against Monopolies.—Mr. Robert Ewen writes, in the Westminster Review, demanding free bank circulation as likely to be a very effective weapon to be used in “the coming contest with monopolists.” The subject seems to have attracted official attention in England in 1875, when Sir Stafford Northcote was Chancellor of the Exchequer. As chairman of the committee appointed to inquire into the working of the Bank Acts, he submitted a memorandum showing that, while certain items of the monopoly enjoyed by the Bank of England had been withdrawn, a residuum of restrictions on issuing banks still remained unrepealed. Some other countries have found a way of giving elasticity to the currency by buying in and laying aside their bonds, as the United States has recently been doing. This can not be done in Great Britain, because the Bank of England and the other bank monopolists block the way. The bank is tied down by acts of Parliament to buy and sell gold at a fixed price, and this restriction has been a cause of panics, whereas had gold been allowed to rise and fall in price, according to supply and demand, and the bank got a free hand in dealing with that commodity and in issuing legal notes to supply the circulating medium, “all would have gone well.” Foreign protectionists now have the power to prevent British goods from getting into their markets by imposing heavy duties on them, and at the same time forcing their produce into British markets, because English laws allow them to get gold 509 from the English cheaper than their goods can be obtained. “Suppose a merchant in Britain buys £100,000 worth of corn from America and gives a check on the Bank of England for the amount of the purchase. The American draws the £100,000 in gold and takes it home; he will have to pay no export or import duty thereon—indeed, the probability is he may get a premium on the gold in America. But reverse the transaction: Suppose the British merchant sold £100,000 worth of his goods to America, there would, in the first place, be the exorbitant duty imposed there upon our manufactures of from forty to fifty per cent. Or suppose our merchant wished to buy corn or any American produce in exchange for his goods in place of bringing money, the case would be different—it would tell against the American farmer, who would get a less price for his corn, etc., than he would have done by free trade.” This instance is given “to show how free trade in gold would bring about free trade and reciprocity between the United States and Britain, and is applicable to every other state with which we trade.... There should be full scope given to all good banks in the country, large or small, to carry on banking business in the best modern manner for the benefit of all parties, so as to encourage and develop all trades and industries.”

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Rats and the Plague.—In his introductory address at the opening of the London School of Tropical Medicine, Dr. Manson preached a war of extermination against rats with the vigor of Cato calling for the destruction of Carthage. “Were I asked,” he said, “how I would protect a state from plague, I would certainly answer, Exterminate the rats as a first and most important measure.” He added, “At the present juncture, were I the responsible sanitary head of any town in Europe, in anticipation of a possibility compared to which in horror and in destructiveness a general European war would be a trifle, I would do my best to have every rat and, if possible, every mouse in my district promptly exterminated.” Dr. Manson does not reveal his plan of campaign. Wholesale poisoning of sewers might have serious disadvantages, and there would be difficulties about inveigling the rodent population of these subterranean health resorts (as some enthusiasts consider them to be) into a lethal chamber. Are we to cry havoc and let slip the *cats* of war? or to hurl an army of snakes against the foe? In either case we might find ourselves in the awkward position of a king who had called a too powerful auxiliary to his aid. Already action is being taken on the rat theory of plague. The French Government has ordered that special precautions are to be taken to prevent the importation of rats in vessels from plague-stricken places. It is to be hoped that similar precautions will be taken in regard to the transports which convey the Indian contingent to the Cape, or the situation there may become complicated by the intervention of an enemy who will deal destruction impartially to Boers and to Britons.

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Forestry in California.—As a remedy for the devastation of the forest lands of California, Marsden Manson, having shown that Government administrations with politics in them can not be trusted in the matter, recommends that all forest reservations and public lands upon mountain slopes within the borders of the State be granted to the University of California in trust, for the purpose of maintaining, developing, and extending the water supply of those regions forever. For this purpose the regents should be empowered to lease, under proper control, the timber cutting and pasturage privileges of those areas, and to use the resultant fund to protect the catchment areas, to maintain a college of practical forestry, to construct reservoirs at such points as may be necessary to the industries of the State, and dispose of the water for the benefit of the trust, to acquire mountain lands to be added to the catchment areas, and to do all such things as may maintain wise systems of forest and water conservation and use. The extent of income-bearing property which can be made available for forest preservation and storage of flood waters, Mr. Manson says, is far beyond the general idea.

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Another New Element.—The mineral pitchblende is distinguished for its radio-activity, or the property it 510 has of emitting the peculiar light-rays which have recently attracted attention. The property has been attributed to the presence of uranium, one of the most radio-active among the known metals. About a year ago the chemists M. and Madame Curie, examining the different substances in pitchblende, found among them two new radiant substances, both more active than uranium, which they called polonium and radium. Polonium was found to be closely akin to bismuth, accompanying that metal in all its reactions, but separable from it by fractionation. Radium resembles barium in its chemical reactions. Recently M. A. Debierne, examining one of the products of solution and precipitation of pitchblende, observed intensified radio-active properties in a portion containing titanium, and on further investigation found still another substance showing the principal analytical properties of titanium, but which emitted extremely active rays. While these rays were comparable with those observed from polonium and radium, the chemical properties are entirely different from those of these substances. Radium, however, is spontaneously luminous, while the new substance is not.

MINOR PARAGRAPHS.

Some recent experiments were made by Armand Gautier on the amount of the chlorides contained in sea air. They were conducted at the lighthouse at Rochedouvres, situated about fifty-five kilometres from the coast, during and after the long continuance of a good breeze directly inshore from the Atlantic. The air was drawn through a long tube containing glasswork, and this well then analyzed. He found that in a litre of air there was only 0.022 of a gramme of chloride of sodium. Small as this quantity is, it suffices, perhaps, with the aid of the traces of sodium present, to give sea air its tonic qualities.

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The second International Congress on Hypnotism is to be held in Paris, August 12 to 16, 1900, Dr. Jules Voisin presiding. The programme of discussions includes such topics as the terminology of hypnotism, its relations to hysteria, its application to general therapeutics, the indications of it and suggestions for the treatment of mental disease and alcoholism, its application to general pedagogy and mental orthopædics, its value as a means of pathological investigation, its relation to the practice of medicine and to jurisprudence, and special responsibilities arising from the practice of experimental hypnotism.

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The following is from a recent letter to Science by Prof. James H. Hyslop, of Columbia University: “So much has been published far and wide this last summer about my intention ‘to scientifically demonstrate the immortality of the soul within a year,’ that it is due to the facts bearing upon the choice between materialism and spiritism to say that I have never made any such professions as have been alleged. I wish the scientific public that still has the bad habit of reading and believing the newspapers to know that I was careful to deny that I made any such pretensions as were so generally attributed to me. More than one half the interviews alleged to have been held with me were the fabrications of reporters who never saw me, and the other half omitted what I did say and published what I did not say.”

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Some novel results have been obtained by M. Baillaud, of the Toulouse Observatory, France, from recent observations of the annular nebula in Lyra and comparisons with photographs taken in 1890. Among them are the discovery of small stars in the central space of the ring, the existence of bright points on the ring itself, a more distinct figure of the central star on the later photographs, giving it the aspect of a true star, and greater brightness in the central space, and certain changes in the shape of the edge of the ring, which shows at one point, more distinctly than in 1890, an eminence indicating a jet of matter escaping from the ring. Other nebulæ, especially that called the Dumb-bell and the nebula in the Crown, are spoken of as exhibiting similar phenomena.

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The Chicago Manual-Training School, which is said to be the first independent manual-training school in the 511
United States, is now in its sixteenth year, having been founded in 1883 by the Commercial Club of Chicago. It has been, since 1897, an integral part of the University of Chicago. While its peculiar feature is manual training, it also furnishes instruction in the essential studies of a high-school course. The shop work and drawing are eminently practical. The making of a machine, such as a lathe or steam engine, is begun by the pupils in the drawing room, and is followed by them through the pattern-making shop, the foundry, and the forge room, and is perfected in the machine shop. The forge tools and engine-lathe tools are made by pupils. The courses of the school include a business course, a technological course, and a college preparatory course.

NOTES.

The Massachusetts Institute of Technology has received, by the will of Mr. Edward Austin, deceased at the age of ninety-four years, a bequest of $400,000, the interest of which is to be used for the assistance of needy and meritorious teachers in prosecuting their studies. In addition to this bequest, the institute received, during 1898, an accession of $928,000 to its general funds, and one of $46,000 to its scholarship funds.

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At the recent meeting of the Allied Scientific Societies, at New Haven, Conn., Mr. G. K. Gilbert, of the United States Geological Survey, was chosen to act as retiring President of the American Association for the Advancement of Science, in place of Prof. Edward Orton, deceased.

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The meeting of the Allied Scientific Societies of the United States was held in New Haven, Conn., during holiday week. It was much larger than either of the meetings previously held, and was attended by nearly five hundred members, representing ten societies—viz., the American Society of Naturalists, the Association of American Anatomists, the American Morphological, Physiological, Psychological, and Chemical Societies, the Society for Plant Morphology and Physiology, the American Association for the Advancement of Science, and the Archæological Association of America. The discussions were all interesting.

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The great Roman Catholic Missionary Society, the Sacred Congregation of the Propagation of the Faith, is reported to have sent a circular to all its missionaries urging them to interest themselves in the collection of natural-history specimens for scientific societies and institutions. This is intended, it is said, to interest and encourage missionaries who have a scientific bent, and to inform the world that the Church is not hostile to biological research.

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We have to record, among the later deaths of men in science, the names of Francis Guthrie, formerly Professor of Mathematics in Graaff Reinet College and afterward in South African College till 1898, aged sixty-eight years; he was interested in botany, on which he gave public lectures, and, with Harry Bolus, revised the order of Heaths for *Flora capensis*; Prof. P. Knuth, botanist and author of researches on the relations of insects and flowers and on cross-fertilization, at Kiel, Germany, aged forty-five years; he had published two of the projected three volumes of the *Handbuch der Blüten Biologie*; Prof. R. Yatube, Japanese botanist; Ferdinand Tiemann, honorary Professor of Chemistry in the University of Berlin; Alexander McDougall, inventor, sixty years ago, of an atmospheric railway, and since of many useful mechanical and chemical appliances, at Southport, England; Dr. Camera Pestana, chief of the Bacteriological Institute at Lisbon, Portugal, of plague, which he contracted while experimenting with it at Oporto; and Prof. Elliott Coues, an American naturalist, most distinguished in ornithology, in Johns Hopkins Hospital, Baltimore, December 25th, after a surgical operation, aged sixty-seven years; he had been a professor in Norwich University, Vermont, and in the National Medical College in Washington, and had done scientific work while in the military service of the Government, in the Geological Survey, and in the United States Northern Boundary Commission; and was the author of several books on ornithology and on the Fur-bearing Animals, besides editing the journals of Lewis and Clark and other books of American exploration.

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Punctuation, hyphenation, and spelling were made consistent when a predominant preference was found in this book; otherwise they were not changed.

Simple typographical errors were corrected; occasional unbalanced quotation marks retained.

Ambiguous hyphens at the ends of lines were retained.

Words originally printed in Greek are shown that way in some versions of this eBook. English transliterations were added to all versions by the Transcribers and are indicated by [Greek:].

Page 467: “Magna Charta” was printed that way.

Page 507: Quotation beginning “we must regard” was not ended by a closing quotation mark. Transcriber added one at the end of the paragraph, after “prove a unity of race.”

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