SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

CHARLES ALLEN MUNN, *President*
361 Broadway, New York
FREDERICK CONVERSE BEACH, *Sec'y and Treas.*
361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year, for the United States or Mexico.....$3.00
One copy, one year, for Canada.. ..... 3.75
One copy, one year, to any foreign country, postage prepaid, £0 18s. 6d. 4.50

THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) .....$3.00 a year
Scientific American Supplement (Established 1876)..... 5.00 "
American Homes and Gardens..... 3.00 "
Scientific American Export Edition (Established 1878)..... 3.00 "

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, SEPTEMBER 7, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE QUEBEC BRIDGE DISASTER.

The collapse of the great Quebec cantilever bridge, with a loss, as at present estimated, of over eighty men, is one of the greatest disasters of the kind that have happened in the history of bridge construction. For a parallel, we must go back to the fatal disaster to the Tay bridge, Scotland, when several spans, containing a whole trainload of passengers, were blown down in a fierce gale of wind, falling into the waters of the Tay, and carrying the passengers entombed in a double cage from which there was absolutely no escape. The fall of the Quebec bridge, however, differs from that of the Tay bridge in the fact that the modern structure was merely in course of erection, and the lives lost are entirely those of the workmen. At the present writing the information available is too meager to admit of any accurate statement as to the immediate cause of the disaster. Judging from the nature of the collapse, and the fact that the portion of the bridge on which it actually commenced is now probably lying in 200 feet of water, the actual facts may never be brought to light. This is the more likely, because the lives of all of the workmen who were engaged at the outermost portion of the bridge were lost, and there will therefore be no close-at-hand eyewitnesses to state where the breaking down of the structure first commenced, and from what cause.

The great Quebec bridge, as designed, is the largest of the cantilever type in the world. It consists of two shore arms of about 500 feet in length, and a central span 1,800 feet, consisting of two cantilever arms and a suspended central span. The bridge is notable as containing the longest span of any bridge yet built or under construction, the main span being 90 feet longer than the longest spans of the Forth bridge in Scotland. The bridge is being built according to the usual methods; the shore arms being erected upon false work, and the river arms built out by overhang, the material being handled by a massive steel traveler. The northern cantilever is practically completed, and, at the time of the disaster, according to the telegraphic dispatches, the southern cantilever had been built out some 850 feet over the main channel. A whistle had just sounded for the men to cease work when the collapse commenced; and, apparently, the first breakdown occurred in the outermost panel of the work. According to the statements of eyewitnesses, the collapse of the cantilever was gradual, the whole length of it failing and falling into the river panel by panel. The structure was crowded with workmen, 92 in all having been upon the work when the disaster occurred. Of these, only a few appear to have been saved. The whole of the southern cantilever, including the shore arm, or about 1,300 feet of the structure, is in the river.

If it be true that the failure commenced at the outermost panel of the bridge, it seems to us entirely possible that the bolts, which had been placed temporarily in the rivet holes of some of the riveted connections, may not have been in sufficient number to carry the load of the new work. It is possible that the heavy traveler had been moved forward on to this work, and that, preparatory for operations the next day, some of the heavy bridge members had also been brought out to the end of the cantilever. We shall hope to give fuller details in our next issue.

PROGRESS OF THE CATSKILL WATER SUPPLY.

The letting of the contract for the construction of the great Ashokan dam, which will form the principal feature of the new water supply for this city, marks an important step in the prosecution of this great enterprise. Although the lowest bid was some $2,000,000 below that of the successful bidder, or $10,000,000 as against $12,000,000, the Commissioners decided to let the contract at the higher figure. This was done under the conviction that it would be impossible for the lowest bidder to carry through this great work for the sum named, the estimates of the Commissioners' own engineers having shown that $10,000,000 was $2,000,000 less than would be necessary to build successfully a dam of this character and magnitude. Mayor McClellan, the Commissioners, and their Chief Engineer, Mr. Waldo Smith, are to be congratulated on the vigor and dispatch which they have shown in the handling of this, New York's greatest municipal undertaking. From its very inception the job has been absolutely free from the taint of political interference. It was the Mayor's wish that the work should be so handled; the Commissioners have been of the same mind; and Mr. Smith is credited with the statement that not a single politician has approached him since the beginning of the work. This is as it should be; and if the work can be carried through to the end on this clear-cut principle, it will serve as an object lesson to the various departments of this city and to the politicians of New York, as a whole, which cannot fail to be most salutary and lasting.

At the present time there are over 700 men engaged in the engineering department, in the work of completing the surveys and locations, and carrying on the many and important borings. With the inception of the actual work of construction, this force will be very rapidly increased; for it will be the policy of the Chief Engineer, who has determined that only the very best work shall enter into the construction, to employ as inspectors young engineers of the proper technical qualifications; "men who feel that their future success depends on their records in their first work, and who cannot be forced by threats or persecution to wink at inferior methods of construction."

THE CRUISE OF OUR BATTLESHIPS TO THE PACIFIC.

Now that the acting Secretary of the Navy has confirmed the statement, made by Secretary Loeb, that a fleet of sixteen battleships will start early in the winter on a cruise to the Pacific, all doubt that this extraordinary maneuver is to be carried through is removed. The acting Secretary states that the fleet will sail from Hampton Roads on December 15, and that it will consist of sixteen battleships, six torpedo boats, four supply ships, and nine colliers, making thirty-seven ships all told. According to the present itinerary, the fleet will reach Trinidad, 1,780 knots distant, on the 23d of December; Rio Janeiro on January 10; and Magdalena Bay by March 5 of next year. Here the fleet will remain one month for target practice. If the present programme is followed, San Francisco, distant 1,000 miles from Magdalena Bay, will be reached April 10. The total distance to be covered on this route is 13,772 miles, and of the whole time consumed on the voyage, the fleet will be cruising sixty-three days, and will be in port coaling and engaged in target practice fifty-two days.

Naturally, the coaling problem is a serious one, and the speed of the fleet has been determined by the necessity for strict economy of fuel. The steaming speed will be about 10 knots an hour, which is considered to be the most economical average speed for the cruise. It is estimated that if the ships start with full coal bunkers, the fleet will require for the whole cruise an additional 100,504 tons of coal, exclusive of the coal consumed on the torpedo boats. This enormous supply will have to be carried on colliers. Four of these, carrying 2,200 tons of coal each, will accompany the fleet as far as Trinidad; and five of our larger colliers, carrying 4,000 tons each, will accompany the fleet as far as Rio Janeiro. Furthermore, it will be necessary to charter twelve additional colliers, four of which will await the fleet at Sandy Point, Magellan Straits; four at Callao, Peru; and four at Magdalena Bay. In addition to the colliers, the "Panther," which is equipped with a complete machine shop, and the supply ships "Culgoa" and "Glacier," will accompany the fleet throughout the entire voyage.

BETTER RAILS FOR 1908.

We understand that the conferences already held of the joint committee of the railways and the rail-makers on the subject of new rail specifications, give reason to expect that the conflicting interests will have no difficulty in framing specifications which will insure a much better quality of steel rail being provided for the forthcoming year. It is likely that the new rail will be of a more satisfactory section, with a better distribution of metal between the head, the web, and the base. On the important subject of what is known in the trade as "minimum discard," that is to say, the least amount that shall be cropped from the head of the ingot, it is likely that the percentage will be increased from 10 per cent to 25 per cent, and the cost of the rails advanced from $28 to $33 per ton. It is not likely that the maximum percentage of phosphorus, which now stands usually at about 0.10 per cent, will be materially reduced in the new specifications; but the manufacturers are so thoroughly alive to the necessity of reducing the phosphorus, that they are rapidly installing open-hearth furnaces, with a view to providing rails carrying the 0.06 per cent of phosphorus demanded by modern conditions.

The proposition of the rail-makers that the weight of even the heaviest 80 and 100-pound rails be increased to meet the higher speeds and heavier loads of modern traffic, is not meeting with much favor, the 100-pound rail, in particular, being considered amply stiff even for modern requirements. The 100-pound rail section was adopted fourteen years ago, at a time when the maximum load on the driving wheels of fast passenger engines was only 20,000 pounds per wheel. The maximum wheel load for passenger engines has gone up to 30,000 pounds, and at the same time there has been an increase both in the number of fast heavy express trains and in the speed of the trains themselves.

On this phase of the subject we are inclined to agree with the position taken by the rail-makers and the locomotive builders; for although the present 80 and 100-pound rail, if rolled of steel of the proper chemical composition, and if given the proper time for thorough mechanical working in the rolls, is sufficiently heavy to carry successfully the heaviest modern traffic during the summer and autumn seasons, we believe that for winter and spring service, when the road is thrown more or less out of line and level by the action of the frost, it would be advantageous if the weight of the rail were increased to 110 or 115 pounds per yard.

WHY EROSION IS GREATER IN LARGE GUNS.

It is a fact well known to artillerists that the erosion of the bore takes place more rapidly in large than in small guns. This is generally considered to be due to the fact that in the larger guns, the hot powder gases are longer in contact with the bore of the gun. The longer period of contact is due to the greater length of the gun, and the longer time that it takes the projectile to travel from the powder chamber to the muzzle. The case has been very clearly stated in a recent article by John F. Meigs, Engineer of Ordnance of the Bethlehem Steel Company, who shows that if we take a number of 50-caliber guns, of various diameters of bore, the charges of powder and the projectiles will vary as the cubes of the calibers, and the pressures in the powder chamber and at the muzzle will be equal in all guns of the same system. Thus in the case of a 3-inch, 50-caliber gun and a 12-inch 50-caliber gun, the velocities at the middle point of the bore and at the muzzle will be the same when the guns are similarly loaded. Consequently, it follows that the time occupied in the passage of a projectile down the bore of the gun will vary directly as the caliber. In the case of the 3-inch gun, the projectile must travel 12½ feet; in the case of the 12-inch gun, 50 feet; and, since the velocities at corresponding points down the bore are similar, the white-hot powder gases will be held within the gun four times as long, in the case of the 12-inch, as in the case of the 3-inch gun, and the surface of the bore will be subjected four times as long to the scoring rush of gas of equally high temperature moving at equal speed.

Now, at the 38,000 pounds pressure, which exists in the chamber of all 50-caliber guns having a muzzle velocity of 3,000 feet per second, the temperature of the gas is about 2,000 deg. Steel will melt at 2,800 deg. Fah., and the temperature of the welding heat of steel is about 2,000 deg. Steel at 800 or 900 deg. Fah. is distinctly softer and has less strength than at ordinary temperatures. Hence, it is reasonable to conclude that the accuracy-life of guns of similar proportion decreases faster, as they are fired, than in simple ratio of the increase of caliber. This is in agreement with the facts; for it is found that the accuracy-life of a 0.33-inch hand-rifle using pressures of 38,000 pounds is about 3,000 rounds; while the upper limit of the life of a 12-inch gun of similar proportion is only 83 rounds. Since it is known that the accuracy-life of a 0.33-inch 50-caliber gun at the pressure given above is 3,000 rounds, it is estimated that the number of rounds which the various calibers of guns will fire before they lose their accuracy is, for the 1-inch, 1,000 rounds; the 3-inch, 330 rounds; the 5-inch, 200 rounds; 6-inch, 166 rounds; the 8-inch, 125 rounds; the 10-inch, 100; and the 12-inch, 83 rounds. It should be understood that the above figures indicate merely the point at which the accuracy of the gun will probably become impaired. The muzzle velocity would not be altered at that point; but there would be a loss of accuracy that would increase steadily with successive rounds, and the projectile would be liable to tumble end over end in its flight.

To the above causes of the more rapid depreciation of the larger guns, should be added, we think, another disadvantage which is inseparably associated with large caliber, and that is, the increasing annular opening at the moment of discharge between the bore of the gun and the wall of the projectile, due to the elastic stretching of the gun under the powder pressure. This annular opening permits a certain amount of the gases to escape, at enormously increased velocity, past the base of the shell, and the cutting action of the gases at this higher speed is, of course, vastly in-

creased. The size of the annular opening will of course increase with the increase of caliber, and in a 12-inch gun will be much greater, and allow a far larger escape of gas per unit of surface, than in a 1-inch gun. How far this fact is contributory to the more rapid erosion we do not undertake to say; but that it is a very material factor, we think can hardly be disputed.

THE SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS—BOSTON MEETING, AUGUST 19 TO 23, 1907.

BY WILLIAM H. HALE, PH.D.

The Seventh International Zoological Congress, which met at the Harvard Medical College, Boston, August 19 to 23, was the first meeting of this congress ever held in America. It was attended by over 500 members, of whom about one-quarter were from abroad, representing all parts of the world—the British Empire, including Australia and Tasmania, as well as England, Scotland, Ireland, and Canada; France, Germany, Belgium, Holland, Austria-Hungary, Switzerland, Russia, Italy, Norway, Brazil, Japan, and China. The programme included over 300 papers read before the several sections.

Prof. Alexander Agassiz presided, and opened the congress at the first general session with a presidential address on American Pioneers in Deep Sea Exploration, presenting a record beginning in 1846. During the greater part of this time Prof. Agassiz has been in charge of exploration or of work connected with it, beginning with the cruise of the "Blake." [His address will be found in full in the current SCIENTIFIC AMERICAN SUPPLEMENT.—ED.] Prof. R. Hertwig followed with an address on "Neuere Probleme der Zellforschung."

At another general session Sir John Murray, of Edinburgh, who commanded the "Challenger" on its three years' cruise, beginning in 1876, stated his conclusions as to the conditions of marine life. After expressing his preference for the term "oceanography" rather than "thalassography," proposed by Prof. Agassiz, he paid his attention to Prof. Petersson, director of the North Sea Biological Station, from several of whose conclusions he dissents. He maintains that ocean currents are mainly the effect of the sun and of winds, hence they are superficial. The ocean depths, from the poles to the equator, are of nearly uniform temperature, being not much above the freezing point of water. Hence life in them is of more uniform type than at lesser depths. Near the poles the surface temperature does not vary more than about 10 deg. F. during the year, remaining always near the freezing point. Near the equator the surface temperature is also limited to about 10 deg., but averages about 70 deg. At intermediate regions is a much wider range of temperature. Warm and cold currents meet; conditions alternately favor and interfere with the life of animals, causing at times great destruction of life because of the change to a temperature either too hot or too cold. The destruction of life at localities where warm and cold currents meet, provides a bountiful food supply, and at these localities come into play all the reason for change in form that obtains anywhere. At these points, therefore, is developed the greatest variety of living forms. The ocean surface generally is covered with algæ and other marine creatures or plants, which subsist on things about them; and on these the deep-sea animals depend for food. These surface forms are so closely related to temperatures, that he could determine the surface temperature by his microscope before the captain of the vessel could get it by his thermometer.

Prof. Jacques Loeb presented his latest conclusions as to artificial generation in a paper entitled "The Chemical Character of the Process of Fertilization." He maintains that as all life phenomena are ultimately chemical, we can only hope to produce life by a series of definite chemical reactions. In the process of fertilization, the spermatozoon produces two kinds of effects upon the egg; it causes it to develop, and it transmits the parental qualities. His address dealt only with the former. The most obvious chemical reaction produced by the spermatozoon on the egg is an enormous synthesis or gathering of nuclear material from the material of the cell. After the entrance of the spermatozoon, the one nucleus of the egg is successively divided into two, four, eight, etc. Each nucleus is of the same size as the original one. Evidently, therefore, the chemical effect is the synthesis of nuclear matter. The nucleus consists of a salt, composed of a base of some protein substance and nucleic acid, the skeleton of which acid seems to be phosphorus. The origin of this phosphorus is obviously the egg itself, since the process goes on just as well when the egg is immersed in sea water deprived of its phosphorus as in phosphatic water.

Free oxygen is essential to the fertilized egg, because the spermatozoon causes or accelerates in the egg still other processes than oxidation. Hydrolyses are some of these processes, and in the absence of oxygen these hydrolyses set up reactions which are incompatible with the life of the egg.

Why the spermatozoon should cause development of the egg is not yet known. Its head is practically egg nucleus, and its tail is a fatty plasm. The fertilizing material, however, must be nearly the same with different eggs, otherwise it could not be understood why animals widely separated, like the crinoids and the mollusks, should be able to fertilize the eggs of the starfish.

Dr. Loeb's first method of obtaining larvæ from unfertilized eggs was by treating them with sea water whose osmotic pressure had been raised about 50 per cent. This method, however, was not successful at all places, which led to the belief that not all the processes were caused in the egg by hypertonic sea water. For example, the membrane normal to eggs naturally fertilized did not occur in the others. But by adding a small but definite amount of a monobasic fatty acid to the eggs developed by hypertonic sea water, they developed into larvæ, in part of which the formation of the membrane occurred in a perfectly normal way. This new method of double treatment has been so successful that "we are now in possession of a method which allows us to imitate more completely the effects of the spermatozoon than the previous purely osmotic method." Marine worms, starfishes, a mollusk, the giant quaker-cap of the Pacific Coast, have been thus fertilized. By adding various chemicals to the solution, Dr. Loeb reached the conclusion that the membrane formation of the egg is connected with the process of solution of a fatty layer underneath the surface film of the egg. He concludes that "the essential feature of the process of fertilization consists first in a liquefaction or hydrolysis, or both, of fatty compounds; and second, in starting the processes of oxidation in the right direction."

Dr. R. F. Scharff, of Dublin, made the opening address before the newly-formed section of zoogeography: "On the Evolution of Continents as Illustrated by the Geographical Distribution of Animals." Some of Dr. Scharff's conclusions are that the Mississippi Valley and the east coast are characterized by the possession of many curious and certainly extremely ancient forms of animal life, which are quite unknown west of the Rockies, but are related to species in Europe and eastern Asia. North America must have been connected with Europe; also with Asia, probably by a land bridge near Bering Strait; but was not connected with South America, as there was no Isthmus of Panama. The West Indian islands were connected. South America was divided east and west by the ocean. The Antilles, Venezuela, and Central America were connected with North America, and formed a bay to the west. There was a land bridge between South America and Africa and Australia. The Melanesian Islands were once part of Australia, with connections to New Guinea and portions of the archipelago. Asia was once joined to Australia by the way of Sumatra and Borneo. Lake Tanganyika was once a bay of the ocean, etc.

An improved system of classification was one of the most important problems considered by the congress. Dr. Theodore Gill read a paper on that subject, which showed that systems now in use are in many respects faulty; and he urged the classification of fishes and birds in uniformity with the methods already applied in classifying mammals.

Many entomologists were in attendance, and some important papers were presented on Economic Entomology. Dr. L. O. Howard, the government entomologist, gave an account of the work with parasites against injurious insects, particularly the gypsy moth and the brown-tail moth in New England, which is now in progress on a much larger scale than was ever before attempted. These insects were accidentally introduced in the northeasterly portion of the United States, but the percentage of parasitism from native parasites was very small, whereas the normal percentage of parasitism in their native homes was enormous. Hence they increased rapidly, till three years ago importation of parasites was begun on an enormous scale, hundreds of thousands of insects containing parasites having been brought each year from their native homes in Europe. Every effort is being made to prevent the escape in this country of the native hyper-parasites—or the parasites on parasites.

Dr. J. B. Smith, State entomologist of New Jersey, read a paper on "Ridding a State of Mosquitoes," as applied in New Jersey. Dr. Smith announces five general deductions: first, that there are an unexpectedly large number of species; second, that their life histories are very varied, and generalized statements about these are unreliable; third, only a few species are really pestiferous; fourth, that some breed only in special places, others everywhere; fifth, that some have limited distribution, others are found everywhere.

In New Jersey nearly ninety per cent of the offensive species breed in salt marshes, and many places formerly considered dangerous as breeding places are relatively safe. A survey has been made and plans adopted to drain these marshes. Work has already been done near populous centers with notable results. No oil or other killing agency is employed.

The meeting was followed by a series of receptions to the members in New York, Philadelphia, and Washington extending over a period of about ten days.

SCIENCE NOTES.

In a recently issued report of the principal chemist of the British government laboratory there is an interesting statement about the value of the eggs of the spur dogfish, a fish which has by its depredations caused much loss to the fishermen on the Devon and Cornwall coasts. The chemist states that the average weight of the egg is 36 ounces, the rough skin or "shell" representing 5.4 per cent. Half the egg consists of water, and the other half of protein and fatty matter in about equal proportions. As the shell of the ordinary hen's egg weighs about 11 per cent of the whole, while the contents have nearly 74 per cent of water, the comparative value of the dogfish egg, used in one way or another, becomes apparent. Dogfish have long been a pest of the fishermen on the southwest coast of England, and a few years ago an attempt was made to place them on the market as food. This effort was attended with little success, there being a prejudice against eating "little sharks." Now the fish are disposed of to those stores—common in England—which supply steaks of fried fish delivered to customers hot from the frying pan. The steaks are carried home to be eaten before they cool.

In a communication made to the Académie des Inscriptions et Belles-letters, the Rev. P. Delattre, who is directing the excavations on the site of Carthage, mentions a recent find which has some interest as bearing upon the history of the early Christian martyrs. According to history, two of the martyrs were St. Perpetuus and St. Felicitas. This is now confirmed by a stone slab which bears their names, along with those of several of their companions who no doubt shared their fate. The slab was found on the site of the ancient basilica. Although broken in a number of fragments, it could be put together so as to read the inscription which is in five lines, each line being preceded by a Latin cross: "Hic sunt martyres Saturus, Saterninus, Ribocatus, Secundulus, Felicit. Perpet. Pas.... Maiulus." This slab was taken from the excavations made in the region known as Mcidfa, and M. Delattre is of the opinion that here was erected the great basilica known as Basilica Major, which was perhaps the oldest in Carthage. According to ancient authors, the martyrs St. Perpetuus and St. Felicitas were buried in the basilica, and it was here that St. Augustine delivered several sermons. But the present inscription is probably not the original one which was placed upon the tombs of the martyrs, as the presence of the Latin cross at the beginning of each line as well as other indications seem to show that it belongs to a later period, possibly a century after the death of the martyrs, which occurred in 203 A. D.

The difficulties that beset some branches of research are well illustrated by the skeleton of an extinct Australian marsupial (*Diprotodon australis*) just set up in South Kensington Museum. It was named about seventy years ago by Sir Richard Owen, who from a few fragments of bone thought the creature a near relation of the kangaroo. From time to time various bones were found which tended to modify this classification, but it was not until fully sixty years after its first naming that, in 1899, remains were found from which the structure of the feet and the general form of the skeleton could be realized. These remains were found by Dr. E. C. Sterling of Adelaide, and, thanks to his efforts, it has now been found possible to set up in the central hall of the Natural History Museum at South Kensington a complete restoration of the skeleton, in which a large number of bones are represented by plaster models, although many of those of the limbs and feet are original specimens. As thus restored, the diprotodon is certainly a strange beast, carrying a huge head, the jaws of which are armed with teeth approximating to the kangaroo type, and having the body very short, the front limbs longer than the hind pair, and the vertebral column much arched, and falling away toward the loins, behind which it terminates in a short tail. As regards bulk, the creature may be compared to an unusually tall and short Sumatran rhinoceros; while in the matter of relationship it appears to come nearest to the wombats.

COMPLETION OF THE SCIENTIFIC AMERICAN TROPHY FOR HEAVIER-THAN-AIR FLYING MACHINES.

As we go to press we have just received word from Messrs. Reed & Barton of the completion of the beautiful silver trophy designed and executed by this firm for us in accordance with the suggestions and ideas which we advanced. An examination of the trophy reveals the fact that it is a masterpiece of the silversmith's art. We have arranged to have it on exhibition at the showrooms of the makers, corner Thirty-second Street and Fifth Avenue, for a few days, and our readers are invited to view it at their convenience. We expect to illustrate and describe the trophy in detail in our next issue. The conditions governing the first competition for the trophy (to be held at the Jamestown Exhibition on September 14) have already been published.