læ with this object, and succeeded, with 51 minutes' exposure, using the dry plate, in getting a good picture of the brighter portions of the nebula. This was the first nebular photograph. With 104 minutes' exposure in March, 1881, with an 11-inch refractor, he secured a still better plate, which showed stars down to the 14.7 magnitude, which were visually beyond the reach of the same telescope. But in March, 1882, he obtained the best picture of this wonderful nebula, with an exposure of 137 minutes. These pictures marked a new era in the study of the nebulæ. When these results were communicated to the French Academy by Dr. Draper, Janssen took up the subject with a silver-on-glass mirror of very short focus, having the extraordinary ratio of aperture to focus of $\frac{1}{3}$; the aperture being 20 inches, with a focus of 63 inches. This remarkable instrument was constructed in 1870 for the total solar eclipse of 1871. With this Janssen found it easy to photograph the brightest parts of the nebula with comparatively short exposures. This extremely powerful photographic instrument seems to have been unused for the past fifteen years; but very recently it has been brought into use again, I understand, with the most astonishing results in photographing the nebulæ. Unfortunately for science, the death of Dr. Draper, in 1882, put a stop in America to the work he had inaugurated. But it was at once taken up in England by Common, who, with a three-foot reflector, attained rapid and immediate success. His photographs of the great nebula of Orion are still classic. They were a great advance over the work of Draper, for the reflector was not only a larger telescope, but was also better adapted for photographic purposes, and especially for photographing the nebulæ. In January of 1883, with only 37 minutes' exposure, he secured what was by far the most striking and beautiful picture which had yet been taken of the great nebula. These pictures greatly extended the region of nebulosity, and the delicate details were also better shown.

The writer remembers how much he was impressed a few years later with the beauty of one of Common's photographs. It created in him the first ambition to do work of this kind. Indeed, this picture, and one of a densely crowded region of a part of the constellation of Cygnus, by the Henry Brothers, first called his attention to the great value of the photographic plate for astronomical purposes. It was at this time that the writer conceived the idea of photographing the Milky Way, though the experiments were not then successful for the want of a proper instrument. The great nebula, which has always had such a fascination for astronomers, was subsequently taken up by Isaac Roberts, who, by very prolonged exposures, still further extended the nebulous region and secured very beautiful pictures of it. Among the finest photographs of this object that have been made in recent years is one taken by Dr. H. C. Wilson at Northfield, Minn., with an 8-inch photographic refractor with an exposure of nine hours. The amount and sharpness of detail shown on this beautiful photograph is very striking, and essentially embraces all that has been done on this nebula by photography up to the present time.

E. E. BARNARD.
YERKES OBSERVATORY.

(To be concluded.)

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*THE INTERNATIONAL CONGRESS OF ZOOLOGY.**

THE Fourth International Congress of Zoology met at Cambridge on Tuesday, August 23d, and the four following days. There were about 300 members present. The attendance from America was scarcely

* Based on reports in the London *Times*.

as large as might have been expected, especially when compared with the representation from Continental countries. The Vice-Presidents elected were Professors R. Collett, von Graaf, Haeckel, R. Hertwig, Jentink, Marsh, Milne-Edwards, Mitsukuri and Salensky.

The scientific proceedings of the Congress were opened by Sir John Lubbock's presidential address, which was delivered in the Cambridge Guildhall. In accordance with the example set by the three previous Presidents — Professor Milne-Edwards, Count Kapnist and Professor Jentink —Sir John Lubbock's address was brief. He began by reading a letter to the Congress from Sir William Flower, and expressed his deep personal regret at that gentleman's absence and his sense of the loss the Congress had thus sustained. He then proceeded to say: I am painfully conscious how inadequately I can fill Sir William Flower's place, but my shortcomings will be made up for by my colleagues, and no one could give our foreign friends a heartier or more cordial welcome than I do. The first Congress was held at Paris in 1889 and was worthily presided over by Professor Milne-Edwards, whom we have the pleasure of seeing here to-day. The second Congress was held at Moscow in 1892, under the presidency of Count Kapnist and under the special patronage of his Imperial Highness the Grand Duke Serge. The third Congress was at Leyden in 1895, under the presidency of Dr. Jentink, Director of the Royal Museum, under the patronage of the Queen-Regent. We assemble here to-day under the patronage of his Royal Highness the Prince of Wales, with the support of her Majesty's government and under the auspices of the University of Cambridge.

Such meetings are of great importance in bringing together those interested in the same science. It is a great pleasure and a great advantage to us to meet our foreign colleagues. Moreover, it cannot be doubted that these gatherings do much to promote the progress of science. What a wonderful thing it would be for mankind if we could stop the enormous expenditure on engines for the destruction of life and property and spend the tenth, the hundredth, even the thousandth, part on scientific progress. Few people seem to realize how much science has done for man, and still fewer how much more it would do if permitted. More students would doubtless have devoted themselves to science if it were not so systematically repressed in our schools; if boys and girls were not given the impression that the field of discovery is well-nigh exhausted. We, gentlemen, know how far that is from being the case. Much of the land surface of the globe is still unexplored; the ocean is almost unknown; our collections contain thousands of new species waiting to be described; the life-histories of many of our commonest species remain to be investigated, or have only recently been discovered.

Take, for instance, the common eel. Until quite recently its life history was absolutely unknown. Aristotle pointed out that eels were neither male nor female and that their eggs were unknown. This remained true until a few years ago. No one had ever seen the egg of an eel, or a young eel less than five centimeters in length. We now know, thanks mainly to the researches of Grassi, that the parent eels go down to the sea and breed in the depths of the ocean, in water not less than 3,000 feet below the surface. There they adopt a marriage dress of silver and their eyes considerably enlarge, so as to make the most of the dim light in the ocean depths. In the same regions several small species of fishes had been regarded as a special family known as leptocephali. These also were never known to breed. It now appears that they are the larvæ of eels, that known

as leptocephalus brevirostris being the young of our common fresh-water eel. When it gets to the length of about an inch it changes into one of the tiny eels known as elvers, which swarm in thousands up our rivers. Thus the habits of the eel reverse those of the salmon. I must not, however, go into detail, but I will take one other case—the fly of the King Charles oak-apple, so familiar to every schoolboy. In this case the females are very common; the eggs were known. But no one had ever seen a male. Hartig in 1843 knew 28 species of cynips, but in 28 years' collecting had never seen a male of any of them. Adler, however, made the remarkable discovery that the galls produced by these females are quite unlike the galls from which they were themselves reared; that these galls produced flies which had been referred to a distinct genus and of which both males and females were known. Thus the gall flies from the King Charles oak-apple (which are all female) creep down and produce galls on the root of the oak, from which quite a dissimilar insect is produced, of which both sexes occur, and the female of which again produces the King Charles oakapple. This is not the opportunity to go into details, and I merely mention this as another illustration of the surprises which await us even in the life history of our commonest species.

Many writers have attributed to animals a so-called sense of direction. I have shown that some species of ants and bees have none. Pigeons are often quoted, but the annals of pigeon-flying seem to prove the opposite. They were jumped, as it were, from one point to another. We know little about our own senses—how we see and hear, taste or smell, and naturally even less about those of other animals. They are no doubt in some cases much acuter than ours, and have different limits. Animals certainly hear sounds which are beyond the range of our ears. I have shown that they perceive the utraviolet rays, which are invisible to us. As white light consists of a combination of the primary colors this suggests interesting color problems. Many animals possess organs apparently of sense and richly supplied with nerves which yet appear to have no relation to any sense known to us. They perceive sounds which are inaudible to us; they see sights which are not visible to us; they, perhaps, possess sensations of which we have no conceptions. The familiar world which surrounds us must be a totally different place to other animals. To them it may be full of music which we cannot hear, of color which we cannot see, of sensations which we cannot conceive. There is still much difference of opinion as to the mental condition of animals, and some high authorities regard them as mere exquisite automata, a view to which I have never been able to reconcile myself. The relations of different classes to one another, the origin of the great groups, the past history of our own ancestors, and a hundred other problems—many of extreme practical importance—remain unsolved. We are, in fact, only on the threshold of the temple of science. As regards these profound problems animals are even more instructive than plants. Ours is, therefore, a delightful and inspiring science.

We are fortunate in meeting in the ancient University of Cambridge, a visit to which is under any circumstances delightful in itself from its historic associations, the picturesque beauty of the buildings, and as the seat of a great zoological school under our distinguished colleague Professor M. Foster.

At the close of the presidential address, which was warmly received, the Vice-Chancellor, Dr. Hill, welcomed the Congress on behalf of the University. Greetings were presented by representatives of foreign na-

tions: Professor Alphonse Milne-Edwards, Director of the Natural History Museum, for France; Professor Schulze, of Berlin, for Germany; Professor Hubrecht, of Utrecht, for Holland; Professor O. C. Marsh for the United States; Professor Salensky, of Odessa, for Russia, and Professor Mitsukuri, of Tokio, for Japan, after which Professor Newton, Chairman of the Reception Committee, acknowledged the graceful expressions of the previous speakers. He claimed that Cambridge attached more value to zoology than did any other university, and exhibited a copy of what he regarded as the first book on zoology which treated the subject in the modern spirit. It was published in 1544 by William Turner, a Fellow of Pembroke Hall.

The most important features of the scientific proceedings of the Congress were two discussions, one on the position of sponges in the animal kingdom, the other on the origin of the mammalia. The former discussion was opened by M. Ives Delage, who said he would limit his remarks to one point in the argument. The doubt as to the affinities of sponges was whether the group Spongida was to be regarded as a distinct phylum which had arisen quite independently, or whether it was only a branch of the Cœlenterate phylum. All zoologists admitted that the sponges lacked several characters found in the typical Cœlenterates, but it was disputed whether these characters necessitated the separation of two groups. The speaker believed that one of the differences was so important as to preclude the inclusion of sponges in the same group as Cœlenterata. In the sponge larva there were two types of cells—collar-cells bearing each a long whip-like flagellum and large rounded cells containing the yolk. The former occurred at the upper end of the larva, the latter at the lower end. From analogy with the Metazoa it would be expected that the lower cells would pass inwards and form the internal element of the larva. But observation showed that the the reverse process occurred. Balfour thought it better to assume that the observers were in error rather than that such an abnormal development could occur. There was, however, now no doubt that the observers were correct, and that two layers of the blastula stage in the sponge were formed in the opposite way to that which occurred in other animals. That was to say, the layer which had the histological character of an ectoderm had the evolution of an endoderm, and the layer that histologically was an endoderm passed to the outside and acted as the surrounding ectoderm. The possibility of this reversal Professor Delage illustrated by reference to experiments on the development of larval echinoderms in which, by raising the temperature, a similar inversion of the two layers was sometimes produced. He, therefore, held that the change was actually in the position of the cells, and not that the endoderm cells had acquired the characters of ectoderm cells, and *vice versa*. He concluded that the sponges began to develop along the same line as the rest of the Metazoa, and that they separated from the main Cœlenterate branch at the stage corresponding to the blastula.

Mr. E. A. Minchin, of Oxford, remarked that it was not until nearly the middle of the present century that the investigations of Dujardin and of Dr. Dobie, of Chester, proved that sponges were animals and not plants. After this point had been settled most observers regarded the sponges as Protozoa, a view based mainly on the histological structure of tissues. When improved methods demonstrated the relations of the constituent cells this theory was discredited; Leuckart, in 1854, pointed out the sac-like form of the adult sponge, which he compared to a polype devoid of tentacles and thread-cells. Haeckel placed

this Cœlenterate theory on a sound basis by his work on the larvæ, which he described as formed of two layers, an ectoderm and an endoderm. The Cœlenterate theory, as modified by the beautiful researches of the Chairman, soon became dominant. It was based on architectural considerations, which rendered the reference of the sponges to the Protozoa impossible. But it did not equally disprove the descent of the sponges from that group. Hence two further rival views had been advanced: (1) that the sponges, though Metazoa, are not Cœlenterata; (2) that the sponges are not Metazoa at all, but have been developed independently. The speaker summarized his own researches on the development of the Ascone sponge, *Clatharina blanca*, and concluded that the evidence appeared to favor the independent descent of the sponges from the Choanoflagellata.

The general discussion was begun by Professor Haeckel, who summarized the historical progress of opinion. He still clung to the Cœlenterate theory, because he thought that the remarkable resemblance between the blastula stages of sponges and of admitted Metazoa, such as some mollusca and amphioxus, proved that the whole metazoan phylum was monophyletic in origin. Dr. Vosmaer, of Utrecht, rather regretted that he had been invited to join in the discussion, because it was very unpleasant for a specialist on a group to be forced into a confession of ignorance regarding it. All he could say was that they did not know the exact position of the sponges in the animal kingdom. Mr. Savile Kent read a statement arguing that the sponges must be the descendants of the Choanoflagellata, as the collared cells of the two groups were known in no other animals and agreed so precisely that they must be homologous. He sketched cases in which Choanoflagellata occurred as aggregates of collared cells resting on cells without the flagella, and thus reproducing the typical structure of the walls of a sponge blastula. He urged that workers on the sponges should acquire some personal acquaintance with the Choanoflagellata. Professor Schulze closed the discussion by a few general remarks, in which he upheld the Cœlenterate view of the sponge affinities. He said all Metazoa could be divided into two sets, those with the elements arranged radially and those in which they were bilateral. He regarded the sponges as members of the former division.

On the third day a discussion on the origin of the mammalia was opened by Professor Seeley, who began by remarking that 30 years ago birds and reptiles were united together owing to the discovery of many features in the skeletons of some fossil reptiles, previously known only in birds. But since then many reptiles have been discovered of which the skeletons show characteristic mammalian features. Accordingly the anomodont reptiles of South Africa and Texas have been united with the mammals as the group Theropsida. The distinctions, based on living reptiles and mammals, on which the separation of the two classes was founded, break down when applied to the fossils. Professor Seeley compared the skeleton of the anomodonts with that of the mammals, and showed, element by element, that there is a remarkable series of resemblances in structure between them. Thus the specialization of the teeth into canines, incisors and molars, once regarded as characteristic of mammals, occurs also among reptiles; and in the genus *Diademodon* there is a beauty of differentiation which can be paralleled only by the molars of insectivores. Similarly with the limbs, that of *Theriodesmus* was thought to prove that animal to be a mammal, but it is now known to be a reptile; and all through the limbs of the anomodonts there runs a strong mammalian strain. The marsupial bones

of the pelvic arch occur in the monotremes, and there is a suggestion of their presence in the anomodonts. In the case of the skull the articulation of the lower jaw in some anomodonts approximates to that of the monotremes, while in others they resemble the marsupials and higher mammals; further the supratemporal and quadrate jugal of Labyrinthodonts may also be represented in Ornithorhynchus, as they certainly are in Pariasaurus. The question is complicated by the fact that the anomodonts show resemblances to more than one mammalian type. For example, the teeth of Diademodont resemble those of the lemurs and of the rodents; and the Theriodont and and Dicynodont groups of the anomodonts show affinities in the two chief divisions of the mammals. Hence Professor Seeley concludes that, though the points of resemblance between the mammalian and anomodontian skeletons show the affinity of the groups, they do not render it probable that the anomodonts are the direct ancestors of the mammals, but only form a collateral line. For the common ancestor of both we must go back to the Devonian or even to the Silurian periods, and the interval between the mammals and the anomodont reptiles is now so small that there is a reasonable probability that it will be completely bridged by the discovery of further specimens.

Professor Osborn, of Columbia University, said that certain general principles were useful guides as to the probable nature of the ancestral mammal; in the present imperfect state of the paleontological record he preferred to commence by working backward from the well known comparatively recent forms. In the first place, mammals possess the power of rapid adaptation to their conditions of life. There have been four main centers of adaptive radiation, of which the best case is that of Australia, where the marsupials have acquired forms which among placental mammals are divided between different orders. The starting point of each adaptive radiation has been a small, unspecialized land mammal. Finally, it is probable that the ancestral mammal was omnivorous. Remembering these principles we can trace the line of mammalian descent backward; it leads us to the Jurassic, when the mammals were all small and belonged to three groups—the primitive insectivores, which have been regarded as marsupials, although there is no evidence to support that view; second, the multituberculata, which are probably early monotremes; third, the marsupials. Reversing the order of inquiry, Professor Osborn then referred to the fact that in the Permian there are three groups of reptiles, one of which is surprisingly mammalian in some of its characters, and tempts us to connect the herbivorous section of anomodonts with the monotremes. He thought, however, that the many striking points of resemblance between these reptiles and mammals were due to parallelism, similar characters having been independently acquired. He agreed with Professor Seeley that the anomodonts are not the direct ancestors of mammals, but are a collateral line. He disagreed with Professor Seeley when the latter sought for a much earlier common ancestor of the mammals and the anomodonts, as the speaker believes that an undiscovered and less specialized third subgroup of anomodonts will be found to be the true ancestor of the mammals. The Chairman, however, has shown that the mammalian egg is amphibian rather than reptilian in character; and if much weight is to be laid on this point, then the mammals may have descended from some reptile which retained certain amphibian characters.

Professor Marsh expressed his belief that the solution of this problem is still in the future. He referred to his discussions of

the question with Huxley in 1876 and with Balfour in 1881, and to subsequent progress due to paleontological discoveries. But in spite of these the great gulf between the mammals and reptiles is still unbridged, and he could not agree with Professor Seeley as to the complete collapse of the distinctions. Four points still remained. Great stress had been laid on the affinities between mammals and anomodonts, as shown by the differentiation of the teeth in the latter into three types; but other reptiles, which no one would regard as allies of the mammals, have the same specialization of the teeth, such as the Patagonian crocodile, *Motosuchus*, and the dinosaur, *Ceratopsia*. Again, there was no known reptile with two occipital condyles, as in the batrachians and the mammals. Reptiles had been described with double condyles, but he had examined the specimens in question, and the condyle in each case was really single and only cordate in shape. Thirdly, the absorption of the quadrate bone in the squamosal was not conclusive, as it occurred among plesiosaurs and dinosaurs as well as anomodonts, and in each case the quadrate bone was still in existence. Finally, in reptiles the lower jaw consists of several bones and in mammals of but one. He had examined the most mammalian of the reptiles, and the sutures between the bones were still apparent. The determination of certain bones as prefrontal he thought should be received with caution. He did not expect that the ancestor of the mammals would be found among the huge anomodonts, but among smaller animals.

Professor Haeckel said that he had discussed the problem with Huxley and Lyell 32 years before, and the former then strongly held the polyphyletic origin of the placental mammals, the carnivorous and herbivorous groups having descended respectively from carnivorous and herbivorous marsupials. This view was now untenable, and the speaker believed that the different series of placental mammals converge so nearly that they must all have been derived from one marsupial ancestor. Mr. Sedgwick said that embryological evidence had been referred to, but he thought it would help very little. For example, there could be no doubt that the ancestors of horses had many toes, those of snakes had limbs, and those of birds had teeth; but no trace of these conditions had been detected by embryology. If no light was thrown on such simple problems as these they had no right to expect any on more remote questions. Reference had been made to Professor Hubrecht's use of the characters of the mammalian ovum. The speaker said it must not be forgotten that in the one genus, *Peripatus*, the eggs vary more than they do in the whole of the mammals. He expected little help from paleontology, as the ancestors of nearly all existing groups lived in the pre-Cambrian period, and all traces of them had been lost. Professor Hubrecht, in closing the discussion, said, in reply to Mr. Sedgwick, that the value of embryology was destructive, not constructive. Its evidence was of value as prohibiting certain lines of speculation. He differed from his great teacher, Professor Haeckel, whose present views he thought untenable, since Hill and Semon had shown that in two genera of Australian marsupials have traces of a placenta been found, which in one case is deciduous. He predicted that one great battlefield in the future of this controversy would be over the question whether mammals had descended from oviparous ancestors.

Many important contributions were presented before the sectional meetings of the Congress, including papers by Professor Haeckel, Professor Milne-Edwards, M. Dubois, Professor Hubrecht, Professor Marsh, Professor Osborn and other leading

zoologists. Dr. Wardell Stiles, of Washington, announced that the Committee on Zoological Nomenclature, which had been appointed at Leyden, had drawn up a report. The Committee were not unanimous, and he thought it would save much time if the subject were not discussed at the present Congress. After the circulation of the Committee's proposals a more profitable discussion could be hoped for at the next Congress. Dr. Sclater, as senior member of the Committee, proposed that the report be referred back for further consideration to the Committee, with powers to add to their number. He thought this step necessary, as the last committee were not unanimous in their conclusions. The Committee had been too small. It consisted of six members, one from each of the leading nationalites, of which never more than four had met. He thought the Committee should consist of at least two representatives of each nationality. Dr. Sclater's motion was carried unanimously.

Numerous entertainments were promised, including a reception at the Cambridge Guildhall, a reception by the Master of Downing College and Mrs. Hill, and a concluding banquet at which speeches were made by Professors Möbius, Waldeyer, Blanchard, Milne-Edwards, Marsh, Osborn and Hubrecht.

Before adjournment Professor Möbius, the senior member of the German delegation, extended a formal invitation to the Congress to meet in Germany three years hence.

THIRD INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY, VIENNA, 1898.

The sessions of this Congress, extending through a week's time, were opened on July the 28th by a public reception held in the Aula of the University of Vienna, Austria.

The opening address was delivered by the President of the Committee on Organization, Professor Dr. von Perger, who took occasion in his remarks to refer to the importance, to the aims and the objects of Applied Chemistry.

Among the speakers who followed von Perger in addressing the assemblage were Professor A. Bauer; Director F. Strohmer, Secretary-General of the Congress; Dr. C. Lueger, burgomaster of Vienna, and Dr. Lieben, representing the Imperial Academy of Sciences.

The Austrian Ministers of State were appointed Honorary Presidents, and some of the delegates of foreign countries were honored by their election to the office of Honorary Vice-Presidents of the Congress.

After the motion made by C. Huck, Halle a. S., that the Committee of Organization be continued in office, had been unanimously adopted, Professor E. Buchner, Tübingen, delivered a most interesting lecture: Fermentation without Yeast-cells.

His exposition, freely illustrated with experiments, was followed by all present with the closest attention; all discussion of the subject was, however, deferred to a later and more opportune occasion.

This ended the morning's doings. In the afternoon organization of the various sections was speedily effected, and thereafter most of these held sessions both mornings and afternoons during continuance of the Congress.

These gatherings of the members were most truly international in their make-up. Predominating in number in most of them were naturally the Austrians, the courteous hosts of the occasion.

To select, at hap-hazard, but a few of the many who took an active part in the proceedings: Strohmer, Wolfbauer, Kutschera, Ludwig, Jolles, Stift, Heger, Murmann, Strache, Teclu, Seidel, Werber