that Mr. Gould some years ago succeeded in bringing a living pair within the confines of the British Islands, and a single individual to London, where it lived two days. The birds were quite lively during the voyage across the Atlantic, but began to droop when off the coast of Ireland; and, as we have said, Mr. Gould succeeded in bringing only one to London alive. Particulars will be found in Mr. Gould's "Monograph of the Trochilidæ."

FURTHER details are to hand of the earthquake which on May 18 caused so much destruction in the valley of Cucuta, in the Republic of New Granada. The destruction to life and property has been almost unprecedented. The German drug store, it is stated, was set on fire by a ball of fire that was thrown out of the volcano, which, at the time the news left, was constantly belching out lava. The volcano has opened itself in front of Santiago, in a ridge called El Alto de la Giracho. In reference to this, see the letter we publish to-day from Mr. W. G. Palgrave.

THE final arrangements have been made for holding the forty-third annual meeting of the British Medical Association, which meets in Edinburgh this year on August 3, under the presidency of Prof. Sir Robert Christison, Bart.

AN exhibition is to be held in Belgium next year of all such apparatus, sanitary arrangements, or scientific appliances as are calculated to preserve health or to save life.

WITH the *Gardener's Chronicle* of last Saturday is published a beautifully illustrated supplement, giving an account of Chatsworth, the seat of the Duke of Devonshire.

THE Brussels Académie Royale has just published a new edition of its "Notices Biographiques et Bibliographique." This volume contains a brief sketch of the history of the Academy, a list of Presidents, honorary, corresponding, and ordinary members and associates in the various classes, followed by brief biographical notices of all the members who have contributed papers, with full lists of their contributions. The volume is a very valuable as well as a very interesting one.

MESSRS. TRÜBNER AND CO. have published a pamphlet by Dr. A. Stœcker (translated by Dr. Harrer) giving much useful information concerning the baths and mineral springs of Wildungen, about one hour's distance from Cassel. The springs, of which there are five in use, are more or less alkaline-chalybeate, and seems to possess important curative qualities. In connection with this subject the following recently published statistics of the numbers of patients that visited the German and Hungarian watering-places during 1874 will be interesting:—Baden-Baden, 41,464; Buziasch, 813; Carlsbad, 20,235; Elster, 4,373; Franzensbad, 7,655; Gleichenberg, 3,373; Gastein, 1,253; Gmunden, 1,202; Giesshübl, 12,625; Gräfenberg, 847; Hall, 2,000; Ischl, 9,386; Ilmenau, 1,468; Krankenheil, 1,010; Königswart, 313; Neuenahr, 3,405; Oeynhausen, 3,254; Kryniza, 2,080; Luhatschowitz, 942; Marienbad, 9,861; Nanheim, 4,152; Pystian, 1,709; Reichenhall, 4,215; Reinerz, 2,352; Rohitsch, 2,603; Szczawinca, 2,033; Teplitz-Trentschin 1,655; Tüffer, 2,061; Vöslau, 3,865; Wartenberg, 805; Warmbrunn, 1,960; and Wiesbaden, 65,800.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomelas*) from S. Africa, presented by Messrs. Donald Currie and Co.; an Indian Coucal (*Centropus rufipennis*) from India, presented by Mrs. Hunter Blair; a Small Hill Mynah (*Gracula religiosa*) from S. India, presented by Sir Charles Smith, Bart.; a Golden Eagle (*Aquila chrysaëtos*) from India, presented by Mrs. Logan Horne; two Chinese Quails (*Coturnix chinensis*) from China, presented by Mr. A. Jamrach; two Virginian Eagle Owls (*Bubo virginianus*) from N. America, deposited; two White-winged Choughs (*Corcorax leucopterus*) from Australia, a Salle's Amazon (*Chrysotis salleæi*) from St. Domingo, purchased; five Australian Wild Ducks (*Anas superciliosa*) bred in the Gardens.

## *RECENT PROGRESS IN OUR KNOWLEDGE OF THE CILIATE INFUSORIA* *

### III.

IT follows from this view that the cavity of the Cœlenterata would represent an intestinal cavity only, while a true body cavity would be here entirely absent. This way of regarding the cavity of the Cœlenterata is at variance with the conclusions of most other anatomists who regard the cœlenterate cavity as representing a true body cavity, or a body and intestinal cavity combined. I had myself long entertained the generally accepted opinion that the cavity of the Cœlenterata represents a body cavity. I must, however, now give my adhesion to the doctrine here advocated by Haeckel, and regard the proper body cavity of the higher animals as having no representative in the Cœlenterata. I believe that this is supported both by the facts of development and by the structure of the mature animal. Indeed, the body cavity first shows itself, as Haeckel has pointed out, in the higher worms, and is thence carried into the higher groups of the animal kingdom.

If such be the real nature of a true intestinal cavity and of a true body cavity, it is plain that neither the one nor the other can exist in the Infusoria, for there is here nothing which can be compared with either the endoderm or the ectoderm.

The whole, then, of the alleged chyme of the Infusoria is nothing more than the internal soft protoplasm of the body. It is quite the same as in Amœba and many other unicellular animals.

The peculiar currents which have been long noticed in the endoplasm of many Infusoria must be placed in the same category with the rotation of the protoplasm observed in many organic cells. Von Siebold, indeed, had already compared the endoplasm currents of the Infusoria to the well-known rotation of the protoplasm in the cells of Chara.

The presence of a mouth and anal orifice in the ciliate Infusoria has been urged as an argument against the unicellular nature of these organisms. The so-called mouth and anus, however, admit of a comparison not in a *morphological* but only in a *physiological* sense with the mouth and anus of higher animals. They are simple lacunæ in the firm exoplasm, and have, according to Haeckel, no higher morphological value than the "pore canals" in the wall of many animal and plant-cells, or the micropyle in that of many egg-cells. Kölliker had already compared them to the excretory canal of unicellular glands. Since, therefore, they do not admit of being homologically identified with the orifices of the same name in the higher animals, Haeckel proposes for them the terms "*Cytostoma*" and "*Cytopyge*."

So also the presence of a contractile vesicle and of other vacuoles affords no solid argument against the unicellularity of the Infusoria. The physiological significance of the contractile vesicles has been variously interpreted. In certain cases a communication with the exterior appears to have been demonstrated, and Haeckel regards them as combining two different functions of nutrition, namely, respiration and excretion. They are in all cases destitute of proper walls, and they have been long recognised as morphologically nothing more than lacunæ filled with fluid. Regular contractile vesicles differing in no respect from those of the ciliate Infusoria are often found in the Flagellata and in the swarmspores of many Algæ.

Besides the constant and regular contracting vacuoles, there occur also others less constant and less regularly contracting. These are found in the softer endoplasm, while the constant and regularly contracting vacuoles occur for the most part in the firmer exoplasm. One is just as much a wall-less vacuole as the other, and the difference between them is to be traced to the difference of consistence in the surrounding protoplasm. Haeckel regards the less constant ones as the original form from which the others have been phylogenetically derived, that is, by a process of inheritance and modification through descent.

The last and most important of the parts which enter into the formation of the Infusorium body, namely, the nucleus, is next discussed. Viewed from a morphological point, it has been already demonstrated that the nucleus is in all Ciliata originally a single simple structure, resembling in this respect a true cell-nucleus. As the Infusorium body approaches maturity we find that with its advancing differentiation peculiar changes occur in the nucleus just as in the rest of the protoplasm, but these changes are entirely paralleled by differentiation phenomena

* Anniversary Address to the Linnean Society, by the President, Dr. G. J. Allman, F.R.S., May 24. Continued from p. 157.

which are known in other undoubted cell-nuclei, as, for example, in the germinal vesicle of many animals, in the nuclei of many unicellular plants, the nuclei of many parenchyma cells of the higher plants, and the nuclei of many nerve-cells. The mature Infusorium nucleus is often vesicle-like, and consists of a delicate investing membrane and fine granular contents, precisely as in the differentiated nucleus of many other cells. In many Ciliata, if not in all, there is within the young nucleus a dark, more refringent corpuscle, which has quite the same relations as the nucleolus of a true cell-nucleus.

Regarded from a physiological, no less than from a morphological point of view, the Infusorium nucleus and true cell nucleus admit of a close comparison with one another. It may be considered as established by the concurrent observations of all investigators, that the nucleus of the Infusoria performs the function of a reproductive organ, though the opinions entertained as to the mode in which it thus acts are extremely divergent.

It is now admitted that in the reproduction of unicellular organisms both in the animal and vegetable kingdom, the nucleus takes an important part, and by its division as a primary act ushers in the division of the rest of the protoplasm. Even in the cells which form constituents of tissues, the part played by the nucleus is altogether similar, its division always preceding the division of the cell itself.

In quite a similar way does the nucleus behave in the ciliate Infusoria. The non-sexual reproduction of the Infusoria by division is perhaps universal. In such cases the division always begins by the spontaneous halving of the nucleus, and this is followed by a similar division of the surrounding protoplasm, exactly as in the ordinary simple cell.

Another phenomenon in which the nucleus plays an important part is named by Haeckel "spore formation." Under this designation he comprehends all those cases in which—the idea of a previous fecundation being rejected—the nucleus breaks into numerous pieces, and each of these, apparently by becoming encysted in a portion of the protoplasm of the mother body, shapes itself into an independent cell—a so-called germ-globule, (*Keimkuget*). Now this is a true spore—just as much so as the spores which arise quite in the same way in unicellular plants. The whole process is to be regarded as a case of the so-called endogenous multiplication of cells.

Most authors, however, take a different view of the nucleus. Following Balbiani, they regard it as an ovary ; and to the fragments into which it breaks up they assign the significance of eggs ; while the so-called nucleolus, which lies outside the nucleus, is, as we have seen, believed to be a testis in which spermatozoa are developed for the fecundation of the eggs.

We must bear in mind, however, that this "nucleolus" has been hitherto found in but a disproportionately small number of species, while the spermatozoal nature of the apparent filaments which have been noticed in it has by no means been proved ; and we have already seen that some observed facts such as those adduced by Bütschli are opposed to the view which would assign to them the nature of true spermatozoa.

As Haeckel remarks, however, even though the so-called nucleolus be really a testis fecundating the eggs or fragments derived from the breaking up of the nucleus, this would afford no valid argument against the unicellularity of the Infusoria, for precisely the same sexual differentiation and reproduction are found in unicellular plants.

It may now, then, be regarded as proved that the process by which the body of the ciliate Infusorium attains a certain degree of differentiation is repeated not only in other unicellular organisms, but in many parenchyma cells both of plants and animals. The difference, as Haeckel with much force points out, between the differentiation process of these parenchyma cells and that of the Infusorium body consists in the fact that in the parenchyma cells the differentiation is a one-sided one, conditioned by the division of labour in the organism of which they form the constituents, while in the Infusorium it is a many-sided one related to all the different directions in which cell-life manifests itself, and resting on a physiological division of labour among the "plastidules" or protoplasm molecules. In other words, the differentiation processes which in multicellular organisms are found distributed among different cells, are united in the single cell of the ciliate Infusorium, thus leading to the formation of an animal very perfect in a physiological point of view, but which morphologically does not pass the limit of a simple cell.

In some rarer cases the Infusorium body is found to enclose two or more nuclei, and Haeckel admits that such Infusoria must strictly be regarded as multicellular, since the nucleus in itself alone determines the individuality of the cell ; but these exceptional cases have no significance for the main conception of the infusorial organism. The multiplication of the nucleus exerts almost no influence on the rest of the organisation, and such "multicellular ciliata" are to be compared with the colony-building forms of the Acinetæ, Gregarinæ, Flagellatæ, and other undoubtedly unicellular organisms.

In conclusion, Haeckel considers the systematic position of the Infusoria. That they are genuine *Protozoa*, having no direct relation to either the Cœlenterata or the Worms, must be now admitted. To this result we are led in the most convincing way by all that we know of their development. In all the animal types which stand above the Protozoa, the multicellular organism is developed out of the simple egg cell by the characteristic process of segmentation, and the cell masses so arising differentiate themselves into two layers—the endoderm and the ectoderm, or the two primary germ lamellæ.* Resting on the fundamental homology of these two layers in all the six higher types of the animal kingdom, Haeckel had already† directed attention to the fact that all these types pass in their development through one and the same remarkable form, to which he gives the name of Gastrula, and which he regards as the most important and significant embryonal form of the whole animal kingdom. This gastrula consists of a multicellular, usually oviform uniaxial, body enclosing a simple cavity—the primordial stomach or intestine cavity, which opens outward on one pole of the axis by a simple orifice—the primordial mouth, and whose walls are composed of two layers, the endoderm or inner germ lamella, and the ectoderm or outer germ lamella.

This larval form has now been shown by the researches of Haeckel, Kowalevsky, Ray Lankester, and others, to occur in members of all the six higher primary groups of the animal kingdom ; and Haeckel, in conformity with what he has called the biogenetic fundamental law‡—the recapitulation of ancestral forms in the course of the development of the individual—had already in a former work§ concluded in favour of a common descent of all the six higher types from a single unknown ancestral form which must have been constructed essentially like the Gastrula, and to which he gives the name of *Gastræa*.

From this common descent the Protozoa alone are excluded, these not having yet attained to the formation of germ lamellæ or of a true intestinal cavity.

He regards this difference between the development of the Protozoa and that of all the other animal types as so important, that he founds thereon a fundamental division of the whole animal kingdom into two great primary sections—the *Protozoa* and the *Metazoa*. The former never undergo segmentation, never develop germ lamellæ, and never possess a true intestinal cavity ; the latter, which include all the other types of the animal kingdom, present a true segmentation of the egg cell, have all two primary germ lamellæ—endoderm and ectoderm—a true intestine formed from the endoderm, and a true epidermis from the ectoderm ; they all pass through the form of the gastrula, or an embryonic form capable of being immediately deduced from it, and (hypothetically) are all descended from a Gastræa.

The only Metazoa which in their existing condition have no intestine are the low worm-groups—Cœstoda and Acanthocephala—but these form only an *apparent* exception, for the loss of their intestinal canal is a secondary occurrence caused by parasitism, and Haeckel regards them as having descended from worms in which the intestine was present.

Several years ago Haeckel united into a separate kingdom, under the name of Protista, certain low organisms, some of which had been previously placed among the Protozoa, while others had been assigned to the vegetable kingdom. To this neutral group he refers the Monera, the Flagellatæ, the Catallactæ, the Labyrinthuleæ, the Micromycetæ, and the Acytariæ and Radiolariæ. After the elimination of these there remain as genuine Protozoa the Amœbinæ, the Gregarinæ, the Acinætæ, and, above all, the the true Infusoria or Ciliata.

The union of the Protista into a distinct kingdom equivalent in systematic value with the animal or vegetable kingdom, can, however, scarcely be maintained. We already know enough of some of them to justify our assigning these to one or other of the two generally accepted organic kingdoms ; and there can be little doubt that, did we know the whole history of the others, as well as the essential difference between the animal and vege-

* The comparison of the endoderm and ectoderm of the Cœlenterata to the two primary germ lamellæ of the Vertebrata was first made by Huxley.
† "Die Kalkschwämme," 1872.
‡ "Generelle Morphologie."
§ "Die Kalkschwämme.

table kingdom, these, too, would be referred without hesitation either to the one or to the other, some passing to the former and others to the latter. The group of the Protista is thus at best but a provisional one, based partly on our ignorance of the structure and life-history of the beings which compose it, and partly on our inability to assign to the animal its essential difference from the plant. Haeckel, however, has done well in specially directing attention to it, and in his admirable researches on many of the organisms which he has thus grouped together he has largely contributed to our knowledge of living forms.

I have thus dwelt at considerable length upon this important paper of Haeckel's, because I think that it not only brings out in a clear light the essential features of infusorial structure and physiology as demonstrated by recent research, but that it goes far to set at rest the controversy regarding the unicellularity and multicellularity of the Infusoria.

Balbiani has quite recently published a very interesting account of the remarkable Infusorium long ago described by O. F. Müller under the name of *Vorticella nassuta*, and more recently taken by Stein as the type of his genus Didinium.

The animal, which is somewhat barrel-shaped, with an anterior and a posterior wreath of cilia, has one end continued into a proboscis-like projection which carries the oral orifice on its summit, while an anal orifice is situated on the point diametrically opposite to this. There is a very distinct cuticle, though the rest of the cortical layer is very thin, and can scarcely be optically distinguished from the internal parenchyma, which exhibits manifest currents of rotation. These flow in a continuous sheet along the walls from the anal towards the oral side, and on arriving at the mouth turn in towards the axis and then flow backwards along this until they complete the circuit by once more reaching the anal side of the body. No trichocysts are developed in the walls of the body. The contractile vesicle is large, and is situated near the anal end; it presents very distinct pulsations, and Balbiani is disposed to believe in a communication between it and the exterior.

During the act of digestion a tubular cavity can be seen running through the axis of the body, and connecting the oral and anal orifices. This is regarded by Balbiani as a permanent digestive canal. The post-oral or pharyngeal portion of this tube possesses a very remarkable feature, namely, a longitudinal striation caused by rigid rod-like filaments which are developed in its walls, and which can be easily detached and isolated by pressure or by the action of acetic acid. They then resemble some common forms of the raphides developed in the cells of plants. The function of these rods becomes apparent when the animal is observed in the act of capturing its prey. The Didinium is eminently voracious and carnivorous, and when in pursuit of other living Infusoria, such as Paramecium, the prey may be seen to become suddenly paralysed on its approach. A careful examination will then show that the Didinium has projected against it some of its pharyngeal rods, and to the action of these bodies the arrest of motion is attributed. A curious cylindrical tongue-like organ is now projected from the mouth towards the arrested prey, to which it becomes attached by its extremity. By the retraction of this tongue the prey is now gradually withdrawn towards the mouth, engulphed in the distended pharynx, and pushed deeper and deeper into the axial canal, where it is digested, and the effete matter ultimately expelled through the anus.

From all this Balbiani concludes against the unicellular doctrine. He sees in the axial cavity a permanent alimentary canal, and in the surrounding parenchyma a true perigastric space filled with a liquid which corresponds with the perigastric liquid of the polyzoa and of many other lower animals. He is not, however, disposed to make too broad a generalisation, and to insist on the presence of an alimentary canal distinct from a body cavity in all the other Infusoria. Here, however, he falls in with the views of Claparede and Lachmann and of Greeff, and maintains that as a rule the digestive and body cavity in the Infusoria are confounded into a single gastrovascular system.

Independently, however, of the untenableness of the conception of a united digestive and body cavity, it does not appear to me that Balbiani makes out any case against the unicellularity of the Infusoria. He admits that except in the pharyngeal and anal portion there is no evidence of a differentiated wall in his so-called digestive canal, and even though it be conceded that the middle portion of this canal constitutes a permanent cavity in the parenchyma, it would not differ essentially from other lacunæ permanently present in the protoplasm of many undoubtedly unicellular organisms. It has been already remarked that a communication between these lacunæ and the external medium is paralleled in many simple cells, and these external communications in Didinium present no feature essentially different.

The pharynx appears to be bounded by an inflection of the cortical layer, and I believe we may regard the rod-like corpuscles here present as a peculiar modification of the trichocysts which in many other Infusoria are developed in the cortical layer of the body. The projectile tongue-like organ is one of the most remarkable features of Didinium; we must know more, however, than Balbiani has told us of it, before we can decide on its real import. It is not improbably a pseudopodial extension of the protoplasm.

Balbiani has followed the Didinium through the process of transverse fission. This is preceded by the formation of two new wreaths of cilia, between which the constriction and division takes place, each half previously to actual separation developing within it such parts as it had lost in the act of division. The only part which in this act becomes divided between the two resulting animals is the nucleus. The so-called nucleolus was not seen by Balbiani, and though he observed two individuals in conjugation by their opposed oral surfaces, he never witnessed anything like the formation of eggs or embryos.

I believe I have now laid before you the principal additions which during the last few years have been made to our knowledge of the Infusoria. But though it will be seen that the labourers in the special field of microscopical research, to which I have confined this address, have been neither few nor deficient in activity, it must not be imagined that the subject has been exhausted, or that many questions, more especially such as relate to development, do not yet await the results of future investigations for their solution.

## PRIZES OF THE FRENCH ACADEMY

AS our readers are aware, the Paris Academy of Sciences holds at the end of December each year a solemn meeting for hearing *éloges* of the departed members, and delivering prizes to the most deserving essayists. But owing to the calamity of the war the prizes for 1873 were distributed in the end of 1874, and the prizes for 1874 remained undistributed. An extraordinary solemnity was celebrated on June 21, for the distribution of the 1874 prizes, and henceforth we hope nothing will prevent the Academy fulfilling its yearly duties with punctuality. M. Bertrand, the new perpetual secretary, read an essay on the life and works of M. Élie de Beaumont, his predecessor in the office. Since Abbé Duhamel, the first of these perpetual secretaries, died, this has been the constant practice. So Abbé Duhamel was praised by Fontenelle, Fontenelle by Fouchy, Fouchy by Condorcet, &c. &c. But M. Élie de Beaumont did not produce any *éloge* on Arago; it will be the next duty M. Bertrand will have to perform, and a very attractive one it is. The following are the results of last year's competition as announced at the meeting:—

1. Grand Prize in the Mathematical Sciences for a Mathematical Theory of the Flight of Birds was not awarded, though 2,000 francs were given to M. Penaud, the author of one of the memoirs, and an "encouragement" of 1,000 francs to the two authors of another memoir, MM. Hureau de Villeneuve and Crocé-Spinelli.

2. This was also the case with the Grand Prize in the Physical Sciences, the subject being Fecundation in Mushrooms. The value of the prize was, however, divided between the authors of two memoirs, viz., MM. Maxime Cornu and Ernest Rose, and M. Sicard.

3. The Poncelet Prize in Mechanics was awarded to M. Bresse, Engineer-in-chief des Ponts et Chaussées, for his work entitled "Cours de Mécanique Appliquée," and particularly for the great progress shown in the part devoted to the resistance of materials.

4. The Montyon Prize in Mechanics to M. Peaucellier, Lieutenant-Colonel of Engineers, for his researches on the transformation of alternate rectilineal motion into alternate circular motion.

5. The Plumey Prize to M. Joseph Farcot for his *servo-moteur*, or *moteur-asservi*, an apparatus which renders the action of the rudder more certain and more easy.

6. The Lalande Prize in Astronomy is a sextuple one, and was divided among MM. Mouchez, Bouquet de la Grye,